

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

**JOINT MOTION TO EXTEND THE DEADLINE TO
COMPLY WITH PATENT RULE 4-3**

Pursuant to the Court's Order, dated October 4, 2006, the parties have been ordered to file a joint claim construction and pre-hearing statement by November 9, 2006, in compliance with Patent Rule 4.3. Rembrandt Technologies, LP ("Rembrandt") and Comcast Corporation; Comcast Cable Communications, LLC; and Comcast of Plano, LP ("Comcast") have agreed to meet and confer in an effort to reduce the number of claims at issue and to narrow the list of terms and issues concerning claim construction. In order to provide the parties adequate time to meet and confer and to prepare the resulting joint claim construction and pre-hearing statement, Rembrandt and Comcast jointly move the Court for an order extending the deadline for the parties to comply with Patent Rule 4.3 to November 14, 2006.

Dated: November 8, 2006

Respectfully submitted,

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ATTORNEYS FOR DEFENDANTS
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ORDER

The Court, having considered the Joint Motion to Extend the Deadline to Comply with Patent Rule 4-3, concludes that the motion is well taken and should be GRANTED.

Accordingly, it is ORDERED that the new deadline for filing the parties P.R. 4-3 is November 14, 2006.

IT IS SO ORDERED.

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

Plaintiff,

V.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Defendants.

Civil Action No. 2-05CV-443

Judge T. John Ward

Jury Demand

DEFENDANT COMCAST CORPORATION'S RESPONSE TO
PLAINTIFF'S MOTION FOR CLARIFICATION REGARDING P.R. 3-1(H)

I. INTRODUCTION

In its Motion for Clarification, Rembrandt does not dispute that it intends to prove the existence of certain claim elements by reference to the source code for the Accused Instrumentalities. In fact, Rembrandt concedes that some devices may not implement the claim elements *except* in software / firmware, and Rembrandt expressly reserves the right to prove infringement with reference to the source code alone. Nevertheless, Rembrandt takes the novel position that it is not bound by the requirements of this Court's Patent Rule 3-1(h), and that it need not update its Preliminary Infringement Contentions to identify the source code of the Accused Instrumentality that allegedly satisfies those software limitations.

Rembrandt's position appears to be that so long as its review of source code is consistent in its mind with the general assertions made in its Preliminary Infringement Contentions ("PICs"), it does not have to comply with Rule 3-1(h). But Rule 3-1(h) contains no such exception, and Rembrandt cites no support for its abridged construction. Contrary to Rembrandt's interpretation, the Court explained in its Amended Discovery Order that the purpose of Rule 3-1(h) is to provide alleged infringers with specific infringement contentions early on in the case, and that the failure to do so hampers a defendant's "ability to prepare a

defense.” (Amended Discovery Order dated Jun. 15, 2006, at 9). For claim elements that are allegedly satisfied by software limitations, the rule could not be any clearer that a plaintiff has 30 days from the receipt of source code to “identify, on an *element-by-element basis* for each asserted claim what source code of each Accused Instrumentality allegedly satisfies the software limitations of the asserted claim elements.” (*See id.* (emphasis added)).

Given that Rembrandt *admits* that it intends to show that certain claim elements are met by software / firmware limitations in the Accused Instrumentalities, Rembrandt should comply with Rule 3-1(h) and supplement its Preliminary Infringement Contentions. Rembrandt should not be allowed to hide the ball regarding which claim elements it contends are met by software limitations, and what software or source code it believes support those contentions. Such tactics are not permitted by the letter or intent of this Court’s rules.

II. BACKGROUND

Rembrandt served its Preliminary Infringement Contentions (“PICS”) on May 12, 2006. Therein, Rembrandt contends that Comcast infringes the patents-in-suit by its adherence to two industry standards: the ATSC standard for United States Patent No. 5,243,627 (“the ‘627 Patent”); and DOCSIS for United States Patent Nos. 5,852,631, 4,937,819, and 5,719,858 (the ‘631, ‘819, and ‘858 Patents”). (*See generally* Ex. A to Mot. for Clarification). The ATSC standard defines certain characteristics for the transmission of digital television signals over the air. DOCSIS is a protocol that defines certain characteristics of high-speed internet service on a cable system. The only details Rembrandt provides in its PICs are citations to these standards. This is so even for those claim elements for which ATSC and DOCSIS are silent because they do not specify all details of compliant equipment. Rembrandt’s PICs do not contain a specific reference to any of the Accused Instrumentalities, or a description of where the claim limitations allegedly can be found in the devices as constructed or implemented. (*See generally id.*). Also, for nearly *every* claim element, Rembrandt states in its PICs that: “This claim element may include features that relate to software of the Accused Instrumentalities, and Rembrandt reserves

the right to supplement or modify these contentions under Judge Ward's modification to the Local Patent Rules, Rule 3-1(h)." (*See generally id.*).

Because Rembrandt did not yet have any software / firmware for the Accused Instrumentalities, and supposedly could only rely on the publicly available standards, Comcast did not object to the adequacy of Rembrandt's Rule 3-1 disclosure. Comcast reasonably expected—in accordance with the Local Patent Rules and this Court's Amended Discovery Order—that for those claim elements that Rembrandt intended to meet by reference to software limitations in the Accused Instrumentalities, Rembrandt would supplement its PICs after receiving the relevant source code. Rembrandt did not do so.

Instead, on November 1, 2006, more than five months after Rembrandt served its PICs, Rembrandt sent a letter to Comcast stating that it did not intend to supplement its PICs, even though it intended to rely on source code to meet certain claim limitations. (*See Ex. C to Mot. for Clarification*). Rembrandt's position, as stated in its letter, is that because its analysis of source code only confirms its earlier contentions, Rule 3-1(h) does not apply. (*See id.*). Rembrandt was careful, however, to reserve the right to rely at trial on any software implementation found in source code, regardless of whether its infringement contentions ever identified how such software complies with the asserted claims. (*See id.*).

On November 3rd Comcast responded to Rembrandt's letter by citing Rule 3-1(h) and requesting that for every claim element Rembrandt contends to be met by a software limitation, Rembrandt supplement its PICs to identify the corresponding source code. (*See Ex. D to Mot. for Clarification*). After an unsuccessful meet and confer, the instant motion followed.

III. ARGUMENT

A. Rembrandt Misinterprets Rule 3-1(h).

Rembrandt contends that Rule 3-1(h) only "applies in a situation where a party cannot 'accurately indicate where the infringement occurs without the source code.'" (*Mot. for Clarification*, at 6 (citations omitted)). Rembrandt then argues that because its PICs provide

some indication of where the infringement occurs, *i.e.*, in the industry standards, and its review of source code to date is consistent in its opinion with those contentions, Rule 3-1(h) is not applicable in this case. (*See id.*). But the language of Rule 3-1(h) is not so limited, and nothing excuses Rembrandt from its obligations under the rule. To the contrary, Rule 3-1(h) applies whenever a party “asserts that a claim element is a software limitation.” (Amended Discovery Order dated Jun. 15, 2006, at 9). In those instances, a party is required within 30 days from the receipt of source code to “identify, on an element-by-element basis for each asserted claim what source code of each Accused Instrumentality allegedly satisfies the software limitations of the asserted claim elements.” (*Id.*). The exception that Rembrandt concocted simply is not supported by the plain language of the rule.

Rembrandt’s narrow interpretation of Rule 3-1(h) also is not supported by *American Video Graphics, LP v. Electronic Arts, Inc.*, 359 F. Supp. 2d 558 (E.D. Tex. 2005), the decision cited by this Court as a basis for its adoption of Rule 3-1(h). In *American Video Graphics*, as here, the plaintiff argued that it had satisfied Rule 3-1, despite not having identified in its preliminary infringement contentions any of the allegedly infringing source code. The Court agreed, stating that “AVG has complied with Rule 3-1(c) to the best of its current ability.” (*Id.* at 561). Nonetheless, “[t]o accommodate Defendants’ need for more specific information,” the court ordered the plaintiff to “supplement its 3-1(c) charts with specific references to the source code within 30 days of Defendants depositing the code into escrow.” (*Id.*). Thus, under *American Video Graphics*, even if Rembrandt’s PICs initially satisfied Rule 3-1, as it claims, Rembrandt is not exempted from supplementing those contentions with references to source code once the source code becomes available.

Furthermore, the exception from Rule 3-1(h) that Rembrandt is seeking is inconsistent with the purpose behind Rule 3-1 and would significantly prejudice Comcast’s ability adequately to defend itself in this litigation. Rules 3-1 and 3-1(h) are designed and intended to provide accused infringers with specific infringement contentions early on in the case: “The Patent Rules require a party asserting claims of patent infringement to take a firm position in the litigation as

it relates to infringement early on in the case [as] parties opposing a claim for patent infringement are hampered in their ability to prepare a defense absent specific infringement contentions.” (Amended Discovery Order dated Jun. 15, 2006, at 9). Under Rembrandt’s interpretation, however, it could hide behind its alleged lack of knowledge about the source code running in the Accused Instrumentalities long after it has had the opportunity to analyze the source code, thus denying Comcast the ability to know how Rembrandt contends there is infringement—not merely hypothetical infringement with reference to a generic standard, but actual infringement by a particular device or service. Such gamesmanship is not permitted by the letter or intent of this Court’s rules.

In short, Rembrandt has, in qualified terms, admitted that various claim elements are software limitations. Once it receives the source code, it must clarify these qualified contentions: either it contends that the claim is satisfied by source code, in which case it must update its contentions with reference to source code, or it must effectively disavow that the claim is satisfied by source code. The one possibility that is not available to Rembrandt is to not amend its contentions with reference to source code and then later seek to use the source code for proof of infringement. To allow Rembrandt this option would vitiate Rule 3-1(h).

B. For Those Claim Elements That Are Not Discussed in the Applicable Standard, Rembrandt Has Not Complied With Local Patent Rules 3-1 or 3-1(h)

Even if the Court were to adopt Rembrandt’s reading of Rule 3-1(h), Rembrandt should still be required to supplement its PICs for at least the claim elements for which Rembrandt has not, and cannot, specifically identify any allegedly infringing structures or operations within the ATSC or DOCSIS standards. For these elements, the specific software / firmware of the Accused Instrumentalities is the only structure Rembrandt possibly can point to in an effort to show that the claim elements are met.

For example, both of the asserted claims (Claims 9 and 19) in the ‘627 Patent purport to claim a “receiver” for receiving and processing a signal with certain characteristics. However, the ATSC standard, which forms the entire basis of the existing infringement contentions, does

not specify the structure or operation of receivers at all. It only describes transmitters. Therefore, it is simply impossible for the current PICs for Claims 9 and 19 to be adequate without supplementation by reference to firmware or software that actually defines the operation of the accused receivers. For instance, the only description Rembrandt provides in its PICS for the “distributed viterbi decoder” element in Claims 9 and 19 is the following.

On information and belief, ATSC compliant receivers necessarily have a distributed Viterbi decoder, or an equivalent circuit or software module, that recovers the originally encoded information encoded by the distributed trellis encoder described in the ATSC Standard.

(Ex. A, Part 1 to Mot. for Clarification, at p. 15 of 50 (emphasis added)). But a “distributed Viterbi decoder” is not discussed anywhere in the ATSC standard. Similarly, for the “deinterleaving the interleaved signal points” elements of Claims 9 and 19, Rembrandt merely states in its PICs that the Accused Instrumentalities “necessarily have” “deinterleaving circuitry or software[.]” (*Id.* at 14 of 50, 22 of 50).

The same is true for the asserted claims in “the ‘631 Patent. Claim 1 of the ‘631 Patent requires both a “plurality of possible physical layer modulations” and a “plurality of possible link layer connections.” (Ex. A, Part 4 to Mot. for Clarification, at 11 of 37 & 13 of 37). While DOCSIS may allow for and accommodate a “plurality” of modulations or connections, the Accused Instrumentalities, as implemented, may only contain one form of modulation or connection. Consequently, Rembrandt necessarily will need to rely on the software or firmware of the Accused Instrumentalities in order to meet these limitations.

Rembrandt’s need to rely on software or firmware to prove infringement is even more obvious with other claim elements in the ‘631 Patent. For example, Claim 10 requires “[a] computer program product having a computer readable medium including computer program logic” (Ex. A, Part 4 to Mot. for Clarification, at 30 of 37). In support of this element, Rembrandt’s PICS, as currently constituted, simply state: “*On information and belief, the Accused Software is a computer program having a computer readable medium including computer program logic recorded thereon.*” (*Id.* (emphasis added)). There can be no question

that this contention fails to meet the requirements of Rules 3-1 and 3-1(h). (*See, e.g., STMicroelectronics, Inc. v. Motorola, Inc.* 308 F. Supp. 2d 754, 755 (E.D. Tex. 2004) (preliminary infringement contentions must provide notice of infringement that goes “beyond that which is provided by the mere language of the patent”)).

In sum, Rembrandt own PICs demonstrate that infringement of many claim elements cannot be proven solely by reference to the industry standards or protocols that currently provide the basis for Rembrandt’s infringement contentions. In order to satisfy its burden of proof with respect to these elements, Rembrandt necessarily will be forced to rely on the software / firmware of the Accused Instrumentalities. Rembrandt concedes as much in its Motion for Clarification, where it seeks to reserve rights to prove infringement of certain claim elements solely by reference to source code evidence while simultaneously shirking its obligations to disclose the source code it intends to rely upon under the rules. (*See* Mot. for Clarification at 4, n.3, 5). Comcast respectfully submits that with respect to these claim elements at a minimum, Rule 3-1(h) requires Rembrandt to update its PICs and identify the particular source code that allegedly supports Rembrandt’s contentions.

C. Rembrandt Cannot Avoid Rule 3-1(h) Merely Because It Believes the Rule Is Onerous In This Case.

Animating Rembrandt’s entire pleading is the notion that Rule 3-1(h), if applied literally, would cause “substantial prejudice” to plaintiffs in cases such as this by requiring unnecessary supplementation of PICs. (Mot. for Clarification, at 5). Rembrandt posits that, absent relief from the Court, it will be forced to supplement its PICs over 30 times in this case, which could trigger a new round of invalidity contentions each time. (*See id.* at 4-5).

In the first instance, Rembrandt can hardly be heard to complain about the burdens of Rule 3-1(h), given that it chose to implicate dozens or more different devices in this lawsuit. The scope of its obligations under Rule 3-1 is coextensive with the sweeping nature of its allegations.

Moreover, Rembrandt mischaracterizes Comcast’s position in an attempt to exaggerate the burdens associated with this rule. If Rembrandt already has provided specific allegations

regarding how the ATSC and DOCSIS standards allegedly read on the asserted claim elements, Comcast is not insisting that Rembrandt supplement its entire PICs every time source code merely confirms that a device complies with those standards. Rather, Comcast is simply requesting that for those claim elements for which Rembrandt cannot provide direct, specific citations to the ATSC or DOCSIS standards to support its PICs, Rembrandt should be required to state which elements it contends are software limitations and to identify the specific software / firmware of the Accused Instrumentalities that allegedly satisfies these limitations. Anything less would deny Comcast notice of Rembrandt's theory of infringement, and would unfairly hamper Comcast's ability to prepare its defense.

Finally, with regard to the timing of any Rule 3-1(h) supplementation of Rembrandt's PICs, Comcast offered to meet and confer to work out a reasonable schedule, but Rembrandt declined Comcast's offer. If the Court concludes that Rule 3-1(h) applies in this case, Comcast submits that the parties should endeavor to work out a reasonable schedule for Rembrandt to comply. But permitting Rembrandt to wait until every last third-party witnesses produces source code, as Rembrandt requests, is both unworkable and unnecessary. Such an outcome almost certainly would leave Comcast in the position of not knowing the specific bases for Rembrandt's contentions until very end of discovery, when it will be too late for Comcast to adjust its defense in response to those contentions. Unlike *American Video Graphics* and other cases, the timing of the production of source code is not in Comcast's control. And with only three companies' source code currently on deposit, it only makes sense that Rembrandt should immediately comply with respect to the devices using those three samples of source code, rather than waiting and attempting to provide disclosures regarding all source code all at once at or near the close of discovery.

IV. CONCLUSION

In trying to argue its way out of Rule 3-1(h), Rembrandt straddles two inconsistent lines of reasoning. On the one hand, Rembrandt claims that any citation to software would "provide[]"

only supplemental evidence of infringement” and is therefore unnecessary. (Mot. for Clarification, at 5). On the other hand, Rembrandt concedes that some devices may not implement the claim elements *except* in software, and Rembrandt therefore expressly reserves the right to prove infringement with reference to software alone. (*See id.* at 4, n.3, 5). Rembrandt cannot have it both ways. If Rembrandt contends that a claim element is met by a software / firmware limitation, it has an obligation under this Court’s Rule 3-1(h) to say so in its Preliminary Infringement Contentions, and to identify the particular source code that supports its contention. If Rembrandt fails to comply with this obligation, Comcast respectfully submits that Rembrandt should not be allowed to later surprise Comcast and rely on source code at trial.

Respectfully submitted,

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**ATTORNEYS FOR DEFENDANTS
 COMCAST CORPORATION,
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 COMCAST OF PLANO, LP**

CERTIFICATE OF SERVICE

The undersigned certifies that the foregoing document was filed electronically in compliance with Local Rule CV-5(a). As such, this answer was served on all counsel who are deemed to have consented to electronic service. All other counsel of record not deemed to have consented to electronic service were served with a true and correct copy of the foregoing by certified mail, return receipt requested, on this 9th day of November, 2006.

/s/ Jennifer Haltom Doan
Jennifer Haltom Doan

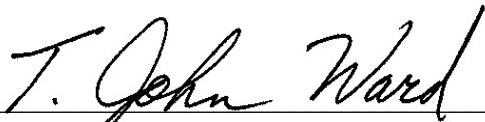
IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANT TECHNOLOGIES, LP	§	
Vs.	§	CIVIL ACTION NO. 2:05CV443
COMCAST CORP., ET AL.	§	

ORDER

Time Warner's unopposed motion for leave to exceed page limits (#90) is granted.

SIGNED this 13th day of November, 2006.



T. JOHN WARD
UNITED STATES DISTRICT JUDGE

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
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Civil Action No. 2:05-cv-00443-TJW

PLAINTIFF’S REPLY IN SUPPORT OF ITS MOTION FOR CLARIFICATION

I. INTRODUCTION

In their Opposition to Plaintiff’s Motion for Clarification (Docket No. 101) (“Opp.”), Defendants (collectively “Comcast”) seek to transform a party’s preliminary infringement contentions into a detailed outline of the evidence Rembrandt intends to marshal at trial, as might be expected in an expert report. Comcast’s position would require Rembrandt to finalize its expert analysis of complex source code within thirty days of receipt of each of approximately thirty productions of source code—and be bound by that analysis. Such a position would impose an unreasonable burden on Rembrandt wholly inconsistent with the purpose behind P.R. 3-1, and should be rejected.

II. ARGUMENT

A. Comcast’s Interpretation of P.R. 3-1 and P.R. 3-1(h) Vitiates the Purpose Behind These Rules

Patent Rules 3-1 and 3-1(h) are intended to give a defendant notice of a plaintiff’s legal contentions. “[A] party may comply with Patent [Rule] 3-1 by setting forth particular theories of infringement with sufficient specificity to provide defendants with notice of infringement.” *STMicroelectronics, Inc. v. Motorola, Inc.*, 308 F.Supp.2d 754, 755 (E.D. Tex. 2004) (brackets in original) (quoting *Network Caching Technology, LLC v. Novell, Inc.*, 2003 WL 21699799 at *4 (N.D. Cal. March 21, 2003)). Indeed, “Patent LR 3-1 *does not require [a party] to produce*

evidence of infringement or to set forth ironclad and irrefutable claim constructions. Rather, Patent LR 3-1 is designed to require parties to crystallize their theories of the case early in the litigation and to adhere to those theories once they have been disclosed.” *Network Caching Technology, LLC v. Novell, Inc.*, 2003 WL 21699799 at *4 (emphasis added) (holding that a party need not include reverse engineering details in preliminary infringement contentions).¹ Thus, a patentee’s P.R. 3-1 disclosures need only place a defendant on specific notice of the nature of the patentee’s infringement allegations; they need not marshal specific evidence in support of those allegations.

Comcast’s interpretation would essentially require that Rembrandt provide portions of Rembrandt’s expert report, in a piecemeal fashion, throughout the course of the litigation. Rembrandt’s experts—Dr. V. Thomas Rhyne and Dr. Stephen B. Wicker, both of whom have numerous other projects and engagements—would be required, within thirty days, repeated over thirty times during the course of this litigation, to analyze source code, and definitively identify all source code upon which they believe they may rely in their final expert reports. This is simply an unreasonable burden to place on Rembrandt’s outside experts.

Rembrandt’s position is consistent and fair. In its P.R. 3-1 disclosures, Rembrandt explained why Comcast infringes the patents-in-suit by virtue of its use of the Accused Instrumentalities. Rembrandt described the relevant aspects of the operation of Comcast’s cable internet and digital television networks. Rembrandt cited the information available to it at the time, namely, the DOCSIS and ATSC standards. With the benefit of discovery, Rembrandt now has substantial other sources of proof available to it. Rembrandt and its experts should be permitted to prove Rembrandt’s case using any evidence produced during discovery, whether

¹ This case is “persuasive” authority in the Eastern District of Texas because “the relevant portions of the Court’s Patent Rule 3-1 are exactly the same as [the Northern District of California’s] Patent LR 3-1.” *STMicroelectronics, Inc. v. Motorola, Inc.*, 308 F.Supp.2d at 755.

that evidence takes the form of source code, chip diagrams, design documents, configuration files or deposition testimony. By contrast, Comcast draws an unsupportable distinction between source code and other evidence, arguing that source code, unlike other evidence, may not be relied upon unless cited in Rembrandt's P.R. 3-1 disclosures.

Contrary to Comcast's argument, the text of this Court's rule does not support Comcast's position. The first sentence of Rule 3-1(h) states that, for software limitations, a plaintiff "*need not* comply with P.R. 3-1 until 30 days after source code for each Accused Instrumentality is produced." (Docket No. 28 at 19 (emphasis added).) This sentence underscores the purpose of the rule, which is to provide an option in the case where a party is unable to comply with P.R. 3-1. The rule is simply not applicable where, as here, a plaintiff *has* complied with P.R. 3-1.²

Fundamentally, the purpose of P.R. 3-1 and 3-1(h) is to ensure that a party defending against a charge of patent infringement has full and fair notice of the contours of the charge. Viewed in this light, Comcast cannot complain about the sufficiency of Rembrandt's disclosures. Rembrandt should not be required to provide Comcast with repeatedly-updated expert reports.

B. Comcast's Argument That Certain Aspects of Rembrandt's Infringement Contentions Are Insufficient Under P.R. 3-1 Do Not Withstand Scrutiny

Equally unsupported is Comcast's assertion that Rembrandt has not complied with P.R. 3-1 with respect to certain claim elements. Comcast wrongly argues that because the ATSC standard does not directly describe the structure of a receiver, then Rembrandt necessarily must rely on the receivers' software to prove its case. (*See Opp.* at 6.) Contrary to Comcast's assertion, because the ATSC standard describes requirements for a digital television transmitter, it necessarily imposes restrictions on the digital television receivers that receive such signals.

² Although Rembrandt contends that it has fully complied with P.R. 3-1, it acknowledges that source code may be produced that might alter Rembrandt's underlying infringement analysis. In such cases Rembrandt will supplement its infringement contentions. It is for this reason that Rembrandt expressly reserved the right to do so in its P.R. 3-1 statement.

Any argument that Comcast is not placed on notice of Rembrandt's theory of infringement of U.S. Patent No. 5,243,627 in light of Rembrandt's P.R. 3-1 statement is spurious.

Comcast's claims regarding U.S. Patent No. 5,852,631 are even more attenuated.

Comcast argues that "the Accused Instrumentalities, as implemented, may only contain one form of modulation or connection." (Opp. at 6.) But the DOCSIS 2.0 standard requires that the DOCSIS 2.0-compliant devices used on Comcast's network support multiple modulations and protocols. Whether Comcast's network in fact takes advantage of multiple modulations and protocols is proved, not by source code, but rather by Comcast's configuration files.

Finally, Comcast's argument that Rembrandt must cite to source code as evidence that the Accused Instrumentalities include "a computer program having a computer readable medium including computer program logic recorded thereon" (Opp. at 6-7) similarly lacks merit.

Rembrandt has fully complied with P.R. 3-1 by showing where this element is met—in Comcast's DOCSIS-compliant computer software. Indeed, it is unclear how Rembrandt could have been any more specific in its P.R. 3-1 disclosure.

C. If the Court Holds That Rembrandt Must Identify Source Code Evidence In Its Infringement Contentions, Rembrandt Should Be Entitled To Do So Fifteen Days Before Its Expert Reports Are Due

The practical effect of Comcast's position is that Rembrandt would be required to thoroughly analyze highly complex source code to identify exactly where in the source code disparate functions take place, all in a 30-day period after receipt of each production of source code, and further that Rembrandt be bound by this expedited analysis throughout the course of the case. Moreover, should Rembrandt and its experts learn more about how the devices at issue in this litigation are structured through its review of later productions of source code, Comcast undoubtedly would argue that Rembrandt could not go back and alter its analysis with respect to source code devices already produced.

Such a requirement would pose a substantial burden on Rembrandt's testifying experts, who cannot constantly devote time to fully analyzing isolated productions of source code on short notice. Rembrandt's experts are entitled to prepare their reports in an orderly manner after careful review of all the evidence, not in a piecemeal fashion, as Comcast's position would require.

In Rembrandt's Opening Brief, Rembrandt requested that P.R. 3-1(h) be applied literally, providing Rembrandt 30 days after the last set of source code is produced to supplement its infringement contentions, if required. If the Court rejects this proposal and also requires Rembrandt to cite source code in its P.R. 3-1 statement, Rembrandt proposes that it be permitted to do so fifteen days prior to the opening expert report deadline.³

This procedure would allow Rembrandt and its experts to fully prepare its case and analyze all the source code produced in a reasonable amount of time. Comcast's defense would not be prejudiced, since Comcast's rebuttal reports are due fifteen days after Rembrandt's opening expert reports, or thirty days after Rembrandt would submit its citations of source code under this proposal. Thus, Comcast's experts will have more than ample time to review and adequately respond to Rembrandt's evidence and Rembrandt's experts' analyses.

III. CONCLUSION

For the foregoing reasons, Rembrandt respectfully requests that this Court allow its motion for clarification and order that Rembrandt not be required to supplement its P.R. 3-1 disclosures to cite source code evidence in support of its current contentions.

³ If the Court orders this relief, Rembrandt notes that the current Docket Control Order would need to be modified to set a date certain by which expert reports must be served.

Dated: November 13, 2006

Respectfully submitted,

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true and correct copy of the above and foregoing document has been served on November 13, 2006 to all counsel of record who are deemed to have consented to electronic service via the Court's CM/ECF system per Local Rule CV-5(a)(3). Any other counsel of record will be served by electronic mail, facsimile transmission and/or first class mail on this same date.

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SEALED DOCUMENT

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

JOINT CLAIM CONSTRUCTION AND PREHEARING STATEMENT

Pursuant to Eastern District of Texas Patent Rule 4-3, Plaintiff Rembrandt Technologies LP (“Rembrandt”), and Defendants Comcast Corporation, Comcast Cable Communications, LLC, and Comcast of Plano, LP (collectively “Comcast”) hereby provide their Joint Claim Construction and Prehearing Statement.

I. AGREED CLAIM CONSTRUCTIONS

The parties have agreed that certain claim terms, phrases, or clauses that were the subject of the parties’ Patent Rule 4-2 Exchange do not presently require construction by the Court, and have removed those claim terms, phrases, or clauses from the charts attached to this pleading.

The parties have also agreed as to the function of certain of the means-plus-function terms in the patents-in-suit. Because the corresponding structure remains in dispute, these terms are listed in exhibit A, attached.

II. DISPUTED CLAIM CONSTRUCTIONS

The parties have set forth their proposed constructions, including the intrinsic and extrinsic evidence relied upon in support thereof, in Exhibit A, attached. The parties reserve the right to rely on any evidence cited by either party. The parties further reserve

the right to offer rebuttal expert testimony on any claim term for which the other party offers expert testimony.

III. ANTICIPATED LENGTH OF CLAIM CONSTRUCTION HEARING

The parties believe that it would be appropriate for the Court to allocate four hours to the claim construction hearing, with two hours allocated to each side, including reserved rebuttal time.

IV. CLAIM CONSTRUCTION WITNESSES

The parties do not anticipate calling live witnesses at the claim construction hearing except as the Court may request. If so requested, Rembrandt would present the testimony of Dr. V. Thomas Rhyne and Dr. Stephen Wicker. Comcast would present the testimony of Dr. Curtis A. Siller, Jr., and Dr. Harry Bims.

V. CLAIM CONSTRUCTION PREHEARING CONFERENCE

The parties do not believe a claim construction prehearing conference is needed, except at the request of the Court.

Dated: November 14, 2006

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing was served by electronic filing to all counsel of record on this 14th day of November, 2006.

/s/ Thomas A. Brown
Thomas A. Brown

EXHIBIT A: DISPUTED CLAIM TERMS

United States Patent No. 5,243,627

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
<p>trellis encoded channel symbol (claims 9, 19)</p>	<p><u>Proposed construction</u></p> <p>A set of one or more trellis encoded signal points that corresponds to a group of bits that is treated as a unit by an encoding system</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract.</p> <p>Figures 1, 2, 3, 4, 5, 6, 7.</p> <p>Column 1, line 34 – column 2, line 50.</p> <p>Column 2, line 61 – column 3, line 3.</p> <p>Column 3, line 19 – column 4, line 24.</p> <p>Column 5, lines 1 – 41.</p> <p>Column 6, line 46 – column 9, line 51.</p> <p>Claims 1, 3, 11, 13, 21 and 23.</p> <p><u>Extrinsic Evidence</u></p> <p>U.S. Patent No. 5,559,561 (REM0086656-REM0086673)</p> <p>U.S. Patent No. 5,706,312 (REM0086674-REM0086687)</p> <p>U.S. Patent No. 5,512,957 (REM0086636-REM0086655)</p> <p>802.14 PHY Proposal, Thomas Kolze (Cable TV Protocol Working Group), October 1995 (COMREM00669632-</p>	<p>The output of a mapper that is generated from the output of a single state transition of a trellis encoder.</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract</p> <p>Col 1 Lns. 38-44; 48-58; 59</p> <p>Col 2 Ln 2; 5-13; 14-18; 21-28; 31-50; 53 – Col. 4 Ln. 3;</p> <p>Col 4 Lns 4-11; 12-24</p> <p>Col 6 Lns 3-23; 36-39; Ln 55 – Col 7 Ln 6</p> <p>Col 7 Lns 9-18; 25-32; 33-54; Ln 55 – Col 8 Ln 9</p> <p>Col 8 Lns 14-35; 38-56; 58 – Col 9 Ln 13</p> <p>Col 9 Lns 14-28; 14-28; 36-44</p> <p>Figures 1-7</p> <p>U.S. Patents Nos. 5,029,185; 3,988,677; 4,677,624; 4,677,625.</p> <p>Prosecution History: December 21, 1992 Amendment, at pgs. 2-6; Notice of Allowability.</p> <p><u>Extrinsic Evidence</u></p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONIC TERMS 1072 (6th ed. 1996) (“Symbol”) (5th definition).</p> <p>JERRY MARTIN ROSENBERG, DICTIONARY OF COMPUTERS, DATA PROCESSING, AND TELECOMMUNICATIONS 518 (1984) (“Symbol”) (3rd definition).</p> <p>JERRY MARTIN ROSENBERG, DICTIONARY OF COMPUTERS,</p>

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>COMREM00669645).</p> <p>Dolinar and Belongie. Enhanced Decoding for the Galileo S-band Mission, August 1993. (REM0086691-REM0086706)</p> <p>Blue Book, Issue-3, Telemetry Channel Coding.</p> <p>Consultative Committee for Space Data Systems, May 1992. (REM0086940-0086981)</p> <p>Technical Report Number 59, Signal Carrier Rate Adaptive Digital Subscriber Line, September 1999. (REM0086707-REM0086896)</p> <p>Data Over Cable Systems Radio Frequency Interface Specification 1.1, Engineering Committee, 2002 (COMREM00845847-COMREM0084624)</p> <p>Data Over Cable Service Interface Specifications 2.0, Radio Frequency Interface Specification, 2003 (REM0065021-REM0065532)</p>	<p>DATA PROCESSING, AND TELECOMMUNICATIONS 479 (1984) ("Signal element") (3rd definition).</p> <p>EZIO BIGLIERI, ET AL., INTRODUCTION TO TRELLIS-CODED MODULATION WITH APPLICATIONS 72-73 (1991).</p> <p>RICHARD D. GITLIN, ET AL., DATA COMMUNICATION PRINCIPLES 355-356 (1992).</p> <p>U.S. Patent No. 4,945,549 at Fig. 1; Col. 4 Lns. 4-31 (filed Sep. 15, 1988).</p> <p>U.S. Patent No. 4,922,507, at Col. 4, Lns. 37-56 (filed Dec. 1, 1987).</p> <p>U.S. Patent No. 5,023,889, at Col. 3, Ln. 38 - Col. 4, Ln. 28 (filed May 31, 1988).</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand this claim term to mean.</p> <p>U.S. Patents Nos. 5,029,185; 3,988,677; 4,677,624; 4,677,625.</p> <p>Prosecution History: December 21, 1992 Amendment, at pgs. 2-6; Notice of Allowability.</p> <p>Wang, et al., U.S. Patent No. 5,052,000.</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract</p> <p>Col 1 Lns. 38-44; 48-58; 59</p> <p>Col 2 Ln 2; 5-13; 14-18; 21-28; 31-50; 53 - Col. 4 Ln. 3;</p> <p>Col 4 Lns 4-11; 12-24</p> <p>Col 6 Lns 3-23; 36-39; Ln 55 - Col 7 Ln 6</p>

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>Col 7 Lns 9-18; 25-32; 33-54; Ln 55 – Col 8 Ln 9 Col 8 Lns 14-35; 38-56; 58 – Col 9 Ln 13 Col 9 Lns 14-28; 14-28; 36-44</p> <p>Figures 1-7</p> <p>U.S. Patents Nos. 5,029,185; 3,988,677; 4,677,624; 4,677,625.</p> <p>Prosecution History: December 21, 1992 Amendment, at pgs. 2-6; Notice of Allowability.</p>
<p>signal point (claims 9, 19)</p>	<p><u>Proposed construction</u></p> <p>A value that is transmitted by a modulator in one signaling interval</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract.</p> <p>Figures 1, 2, 3, 4, 5, 6 and 7</p> <p>Column 2, lines 5 – 50.</p> <p>Column 3, line 4 – column 4, line 51.</p> <p>Column 5, line 1 – column 6, line 26.</p> <p>Column 6, line 48 – column 9, line 51.</p> <p><u>Extrinsic Evidence</u></p> <p>U.S. Patent No. 5,559,561 (REM0086656-REM0086673)</p> <p>U.S. Patent No. 5,706,312 (REM0086674-REM0086687)</p> <p>U.S. Patent No. 5,512,957 (REM0086636-REM0086655)</p>	<p>A single mapped point in a signal constellation.</p> <p><u>Extrinsic Evidence</u></p> <p>EDWARD A. LEE, DIGITAL COMMUNICATION 186-187 (1988).</p> <p>GILBERT HELD, DICTIONARY OF COMMUNICATIONS TECHNOLOGY 400 (2d ed. 1995) (“Signal constellation”).</p> <p>RICHARD D. GITLIN, ET AL., DATA COMMUNICATION PRINCIPLES 355-356 (1992).</p> <p>Wang, et al., U.S. Patent No. 5,052,000.</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand this claim term to mean.</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract</p> <p>Col 1 Lns 29-33; 54-58</p> <p>Col 2 Lns 5-13; 14-18; 21-28; 31-50; 53 – Col. 4 Ln. 3</p>

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>Col 3 Lns 4-10; 30-44; 56-60; 65 – Col 4 Ln 3 Col 4 Lns 4-11; 35-46 Col 5 Lns 24-41; 44 – Col 6 Ln 26 Col 6 Ln 48 – Col 8 Ln 9 Col 8 Lns 14-35; 38-56; 58 – Col 9 Ln 13 Col 9 Lns 14-28; 29-44; 45-49</p> <p>Figures 1-7</p> <p>U.S. Patents Nos. 5,029,185; 3,988,677; 4,677,624; 4,677,625.</p> <p>Prosecution History: December 21, 1992 Amendment, at pgs. 2-6; Notice of Allowability.</p>
<p>Distributed Viterbi decoder (claims 9, 19)</p>	<p><u>Proposed construction</u></p> <p>A Viterbi decoder having multiple Viterbi decoding processes operating on separate portions of a stream of data to be decoded</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract.</p> <p>Figure 3, 4, 5, 6 and 7.</p> <p>Column 1, line 34 – column 2, line 20.</p> <p>Column 4, line 52 – column 5, line 41.</p> <p>Column 6, lines 12 – 26.</p> <p>Column 6, line 48 – column 8, line 13.</p> <p>Column 8, line 57 – column 9, line 28.</p> <p>Column 9, line 52 – column 10, line 3.</p> <p>Prosecution History, Office Action Response dated</p>	<p>Two or more structures operating in parallel employing the Viterbi algorithm.</p> <p><u>Intrinsic Evidence:</u></p> <p>Abstract</p> <p>Col 1 Lns 29-33; 34-46; 59-65</p> <p>Col 2 Lns 5-13; 14-18; 21-28; 31-50; 53 – Col. 4 Ln. 3</p> <p>Col 6 Lns 12-26; 62-66</p> <p>Col 8 Ln 58 – Col 9 Ln 13</p> <p>Figures 1, 3-4</p> <p>U.S. Patents Nos. 5,029,185; 3,988,677; 4,677,624; 4,677,625.</p> <p>Prosecution History: December 21, 1992 Amendment, at pgs. 2-6; Notice of Allowability.</p> <p><u>Extrinsic Evidence:</u></p>

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>December 21, 1992 at TKHR 0000886 – TKHR 0000890.</p> <p><u>Extrinsic Evidence</u></p> <p>U.S. Patent No. 4,677,625 (COMREM00669498-COMREM00669505)</p>	<p>MICROSOFT COMPUTER DICTIONARY 167 (5th ed. 2002) (“Distribute”).</p> <p>MERIAM-WEBSTER COLLEGIATE DICTIONARY 337 (10th ed. 2001) (“Distribute”).</p> <p>WIKIPEDIA, available at http://en.wikipedia.org. (“Viterbi decoder”).</p> <p>MCGRAW-HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS 2265 (6th ed. 2003) (“Viterbi algorithm”).</p>
<p>means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols (claim 9)</p>	<p><u>Proposed construction</u></p> <p>Interpreted under 35 U.S.C. § 112, ¶ 6.</p> <p>Function: to reverse the process of interleaving performed in the transmitter to recover multiple streams of trellis encoded channel symbols from the interleaved signal points</p> <p>Structure: signal point deinterleaver 441 or switching circuit 431, or a software based deinterleaver or switching circuit, and equivalents</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract.</p> <p>Figures 4, 5, 6 and 7.</p> <p>Column 5, line 67 – column 6, line 26.</p> <p>Column 8, line 57 – column 9, line 13.</p> <p>Column 9, line 45 – column 10, line 3.</p> <p>Refer also to intrinsic evidence cited in support of the</p>	<p>Means plus function claim to be construed pursuant to § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Deinterleaving the interleaved signal points to recover the plurality of streams of trellis encoded channel symbols</p> <p><u>Structure:</u></p> <p>Figure 4 (Streams 456/442, Blocks 441/431, Elements 441/4412); Figure 7 (Streams 456/442, Block 741, Elements 7411/7412/7413/7414); Col 2: Lns 39-42, 48-50; Col 5: Ln 67 - Col 6 Ln 20; Col 8: Ln 62 - Col 9 Ln 51.</p> <p><u>Intrinsic Evidence:</u> Refer to intrinsic evidence cited in support of the claim terms: “trellis encoded channel symbols”; signal points”; and “plurality of streams of trellis encoded channel symbols”.</p> <p>Prosecution History: December 21, 1992 Amendment, at pgs. 2-6; Notice of Allowability.</p>

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	claim terms "trellis encoded channel symbol" and "signal point"	<p><u>Extrinsic Evidence:</u></p> <p>Extrinsic evidence cited above relating to component terms.</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.</p>

United States Patent No. 5,852,631

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
<p>physical layer (claims 1, 6, 10)</p>	<p><u>Proposed construction</u></p> <p>The physical layer is the lowest layer of the Open Systems Interconnect (OSI) seven layer model, and is concerned with establishing the mechanical, electrical, functional, and procedural connection between two modems.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract, FIGS 2-8; 1:23-2:39; 2:62-3:15; 3:34-58; 4:5-18; 5:42-11:27; claims 1, 2, 6, 7, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23, 1998.</p> <p><u>Extrinsic evidence</u></p> <p>Hubert Zimmermann, "OSI Reference Model—The ISO Model of Architecture for Open Systems Interconnection," IEEE Transactions on Communications, vol. 28, No. 4, April 1980, pp. 425-432 (REM0086902-REM0086909).</p> <p>Society of Cable Telecommunications Engineers, Cable-Tec Expo '98 (Denver Colorado, June 10-13, 1998)</p>	<p>The physical layer is the lowest layer of the Open Systems Interconnect (OSI) seven layer model, which is concerned with establishing the electrical and mechanical connection between two modems.</p> <p><u>Intrinsic Evidence:</u></p> <p>Abstract Col 1 Ln 62 – Col 2 Ln 11 Col 2 Lns 12-18; 33-39; 39-59; 62 – Col 3 Ln 21 Col 3 Lns 4-13; 24-61 Col 5 Lns 5-24 Col 6 Lns 24-36; 37-56; 66 – Col 7 Ln 29 Col 10 Lns 57-59, 63 – Col 11 Ln 10 Col 11 Lns 23-28; 33-42 Col 12 Lns 43-54 Col 13 Lns 23-41</p> <p>Figures 1-8</p> <p>U.S. Patents Nos. 4,905,282; 5,425,080; 5,710,761.</p> <p>Prosecution History: Preliminary Amendment, submitted on March 20, 1997, at pg. 2; First Response With Amendments, submitted on October 23, 1997, at pgs. 5-13; Response to Final Rejection, submitted on January 23, 1998, at pgs. 2-10; Third Response, submitted on April 23, 1998, at pg. 3; Transmittal of New Drawings, submitted on July 27, 1998; Notice of Allowability.</p> <p><u>Extrinsic Evidence:</u></p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>(COMREM 00982076-00982709).</p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (6th ed. 1996) (REM0086899-REM0086900) (definition of "physical layer").</p> <p>DSET, LNP Automation Solution: Local Service Management System (LSMS) for Comcast (December 8, 2004) (COMREM00960142-COMREM00960170).</p>	<p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONIC TERMS 203 (6th ed. 1996) ("Connection") (5th definition).</p>
negotiated physical layer modulation (claims 1, 6, 10)	<p><u>Proposed construction</u></p> <p>A physical layer modulation selected by a process permitting two modems supporting different physical layer modulations to agree on a physical layer modulation, in which one modem presents one or more options, and the other modem selects from among the presented options.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract, FIGS 2-8; 1:23-2:39; 2:62-3:15; 3:34-58; 4:5-18; 5:42-11:27; claims 1, 2, 6, 7, and 10</p> <p>Office Action of September 4, 1997 (TKHR00000181-TKHR00000189); Response of October 23, 1997 (TKHR00000165-TKHR00000179); Office Action of November 21, 1997 (TKHR00000156-TKHR00000162); Response of January 22, 1998 (TKHR00000144-TKHR00000154); Office Action of February 19, 1998 (TKHR00000136-TKHR00000143); Response of April 23,</p>	<p>A physical layer modulation agreed upon between two modems after exchanging information at run time.</p> <p><u>Intrinsic Evidence:</u></p> <p>Abstract Col 1 Lns 17-21; 37-48; 49-51; 55-61; 62 – Col 2 Ln 11 Col 2 Lns 12-18; 33-39; 39-59; 62 – Col 3 Ln 21 Col 3 Lns 24-61 Col 6 Lns 24-39; 37-56; 66 – Col 7 Ln 2 Col 7 Lns 15-30 Col 8 Lns 23-41 Col 11 Lns 39-46</p> <p>Figures 1-8</p> <p>U.S. Patents Nos. 4,905,282; 5,425,080; 5,710,761.</p> <p>Prosecution History: Preliminary Amendment, submitted on March 20, 1997, at pg. 2; First Response With Amendments, submitted on October 23, 1997, at pgs. 5-13; Response to Final Rejection, submitted on January 23, 1998, at pgs. 2-10; Third Response, submitted on April 23, 1998, at pg. 3; Transmittal of New Drawings, submitted on</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>1998.</p> <p><u>Extrinsic evidence</u></p> <p>U.S. Patent No. 4,905,282 (REM0086910-REM0086924)</p> <p>U.S. Patent No. 5,491,720 (REM0086925-REM0086935)</p> <p>IEEE Std 802.3u-1995, § 28 (COMREM 671706-672120).</p> <p>Draft CEA-679-C, National Renewable Security Standard (NRSS) (COMREM50007474).</p> <p>Rembrandt incorporates by reference the intrinsic and extrinsic evidence cited for the term "physical layer modulation."</p>	<p>July 27, 1998; Notice of Allowability.</p> <p><u>Extrinsic Evidence:</u></p> <p>"Negotiation": When a connection is established between the virtual terminals in different systems, an initial dialogue is needed to establish the parameters that each will use during the transaction. This is known as the negotiation phase." GILBERT HELD, DICTIONARY OF COMMUNICATIONS TECHNOLOGY 285 (2d ed. 1995).</p> <p>"Negotiate": To confer with another or others in order to come to terms or reach an agreement To arrange or settle by discussion and mutual agreement. THE AMERICAN HERITAGE DICTIONARY OF THE ENGLISH LANGUAGE 1176 (4th ed. 2000).</p> <p>"Negotiate": to arrange for or bring about through conference, discussion, and compromise." MERIAM-WEBSTER COLLEGIATE DICTIONARY 775 (10th ed. 2001).</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand this claim term to mean.</p>
physical layer modulation (claims 1, 6, 10)	<p><u>Proposed construction</u></p> <p>A protocol that is concerned with establishing the mechanical, electrical, functional, and procedural connection between two modems.</p> <p>The physical layer is the lowest layer of the Open Systems Interconnect (OSI) seven layer model, and is concerned with establishing the mechanical, electrical, functional,</p>	<p>The process or protocol that defines how bits are translated into waveforms and transmitted at the physical layer.</p> <p>The physical layer is the lowest layer of the Open Systems Interconnect (OSI) seven layer model, which is concerned with establishing the electrical and mechanical connection between two modems.</p> <p><u>Intrinsic Evidence:</u></p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>and procedural connection between two modems.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract, FIGS 2-8; 1:23-2:39; 2:62-3:15; 3:34-58; 4:5-18; 5:42-11:27; claims 1, 2, 6, 7, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23, 1998.</p> <p><u>Extrinsic evidence</u></p> <p>Hubert Zimmermann, "OSI Reference Model—The ISO Model of Architecture for Open Systems Interconnection," IEEE Transactions on Communications, vol. 28, No. 4, April 1980, pp. 425-432 (REM0086902-REM0086909).</p> <p>Society of Cable Telecommunications Engineers, Cable-Tec Expo '98 (Denver Colorado, June 10-13, 1998) (COMREM 00982076-00982709).</p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (6th ed. 1996) (REM0086899-REM0086900) (definition of "physical layer").</p> <p>DSET, LNP Automation Solution: Local Service</p>	<p>Abstract</p> <p>Col 1 Lns 17-20; 37-48; 49-51; 55-61; 62 – Col 2 Ln 11</p> <p>Col 2 Lns 12-18; 29-38; 39-59; 62 – Col 3 Ln 21</p> <p>Col 3 Lns 24-61</p> <p>Col 4 Lns 41-44, 48-51, 56-58</p> <p>Col 5 Lns 8-10, 24-25, 33-34; 49 – Col 6 Ln 11</p> <p>Col 6 Lns 12-23; 24-56; 57-65</p> <p>Col 7 Lns 15-30; 35-38;</p> <p>Col 8 Lns 23-41; 48-51</p> <p>Col 9 Lns 4-8; 15-22; 32-34, 38-46; 54-57, Col 10 Lns 1-4</p> <p>Col 10 Lns 26-31; 57 – Col 11 Ln 10</p> <p>Col 11 Lns 30-46</p> <p>Col 12 Lns 45-50; 59-65</p> <p>Col 13 Lns 23-41</p> <p>Col 14 Lns 1-5</p> <p>Figures 1-8</p> <p>U.S. Patents Nos. 4,905,282; 5,425,080; 5,710,761.</p> <p>Prosecution History: Preliminary Amendment, submitted on March 20, 1997, at pg. 2; First Response With Amendments, submitted on October 23, 1997, at pgs. 5-13; Response to Final Rejection, submitted on January 23, 1998, at pgs. 2-10; Third Response, submitted on April 23, 1998, at pg. 3; Transmittal of New Drawings, submitted on July 27, 1998; Notice of Allowability.</p> <p><u>Extrinsic Evidence:</u></p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONIC TERMS 662 (6th ed. 1996) ("Modulation") (1st and 5th definitions).</p> <p>MICROSOFT COMPUTER DICTIONARY 346 (5th ed. 2002)</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	Management System (LSMS) for Comcast (December 8, 2004) (COMREM00960142-COMREM00960170).	<p>("Modulation") (2nd definition).</p> <p>EDWARD A. LEE, DIGITAL COMMUNICATION 679 (1988).</p> <p>WILEY ENCYCLOPEDIA OF ELECTRICAL AND ELECTRONICS ENGINEERING 668 (John G. Webster, ed.) (1999).</p> <p>ANDREW S. TANENBAUM, COMPUTER NETWORKS 29-30 (3d ed. 1996).</p> <p>THE COMMUNICATIONS HANDBOOK 573 (Jerry D. Gibson, ed.) (1996).</p>
link layer (claims 1, 3, 4, 6, 8, 9, 10)	<p><u>Proposed construction</u></p> <p>The link layer is the second lowest layer of the Open Systems Interconnect (OSI) seven layer model, and provides the functional and procedural means to transfer data between modems, and to detect and correct errors that can occur in the physical layer.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract; FIGS. 2-8; 1:23-61; 2:40-59; 2:62-3:15; 3:34-58; 4:5-18; 11:30-13:41; claims 1, 3, 4, 6, 7, 9, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23, 1998.</p>	<p>The link layer is the second lowest layer of the Open Systems Interconnect (OSI) seven layer model, which performs error checking functions as well as error correction through frame retransmission.</p> <p><u>Intrinsic Evidence:</u></p> <p>Abstract</p> <p>Col 1 Lns 17-21; 27-48; 51-54; 55-61</p> <p>Col 2 Lns 39-59; 62 – Col 3 Ln 21</p> <p>Col 3 Lns 24-61</p> <p>Col 6 Lns 57-65</p> <p>Col 11 Lns 23-28; 30-51; 52-58; 59 – Col 12 Ln 8</p> <p>Col 12 Lns 9-36, 36 – Col 13 Ln 4</p> <p>Figures 1-8</p> <p>U.S. Patents Nos. 4,905,282; 5,425,080; 5,710,761.</p> <p>Prosecution History: Preliminary Amendment, submitted on March 20, 1997, at pg. 2; First Response With Amendments, submitted on October 23, 1997, at pgs. 5-13; Response to Final Rejection, submitted on January 23,</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p><u>Extrinsic evidence</u></p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (6th ed. 1996) (REM0086897-REM0086898) (definition of "link layer").</p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (6th ed. 1996) (REM0086897-REM0086898).</p> <p>Hubert Zimmermann, "OSI Reference Model—The ISO Model of Architecture for Open Systems Interconnection," IEEE Transactions on Communications, vol. 28, No. 4, April 1980, pp. 425-432 (REM0086902-REM0086909).</p>	<p>1998, at pgs. 2-10; Third Response, submitted on April 23, 1998, at pg. 3; Transmittal of New Drawings, submitted on July 27, 1998; Notice of Allowability.</p> <p><u>Extrinsic Evidence:</u></p> <p>EDWARD A. LEE, DIGITAL COMMUNICATION 679 (1988).</p> <p>WILEY ENCYCLOPEDIA OF ELECTRICAL AND ELECTRONICS ENGINEERING 668, 670 (John G. Webster, ed.) (1999).</p> <p>THE COMMUNICATIONS HANDBOOK 573 (Jerry D. Gibson, ed.) (1996).</p> <p>ANDREW S. TANENBAUM, COMPUTER NETWORKS 30 (3d ed. 1996).</p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONIC TERMS 203 (6th ed. 1996) ("Connection") (5th definition).</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand this claim term to mean.</p>
<p>establishing said link layer connection based upon said negotiated physical layer modulation. (claims 1, 6, 10)</p>	<p><u>Proposed construction</u></p> <p>The link layer connection is established substantially instantaneously upon the completion of the physical layer negotiation, using information derived from the negotiated physical layer modulation.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract; FIGS. 2-8; 1:23-61; 2:40-59; 2:62-3:15; 4:5-18;</p>	<p>Link layer: The link layer is the second lowest layer of the Open Systems Interconnect (OSI) seven layer model, which performs error checking functions as well as error correction through frame retransmission.</p> <p>Negotiated physical layer modulation: A physical layer modulation agreed upon between two modems after exchanging information at run time.</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>11:30-13:41; claims 1, 3, 4, 6, 7, 9, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23, 1998.</p> <p>Rembrandt incorporates by reference the definitions and intrinsic and extrinsic evidence cited above for "link layer" and "negotiated physical layer modulation."</p>	<p>Comcast does not believe that the rest of this term needs to be construed, but reserves its right to argue its ordinary meaning and to counter Rembrandt's proposed construction.</p>
<p>means for establishing a physical layer connection between said calling and said answer modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations (claim 6)</p>	<p><u>Proposed construction</u></p> <p>Interpreted under 35 U.S.C. § 112, ¶ 6.</p> <p>Function: Establishing a physical layer connection based on a negotiated physical layer modulation</p> <p>Structure: a modem configured to establish a physical layer connection based on a negotiated physical layer modulation.</p> <p>In the event the Court holds that the structure corresponding to the recited function must be an algorithm, Rembrandt designates the following alternative structures: FIG. 4, boxes labeled "Finish dialing and send Clqck-cell signal (1500 & 1900)," "1680 Hertz," "800 Hertz," "Detect other answer signal"; "Perform modem</p>	<p>Means plus function claim to be construed pursuant to § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Establishing a physical layer connection based on a negotiated physical layer modulation.</p> <p><u>Structure:</u></p> <p>Figs. 4-9; Col. 8, Ln. 23-Col. 9, Ln. 8; Col. 9, Lns. 15-46; Col. 9, Ln. 47-Col. 10, Ln. 56.</p> <p><u>Intrinsic Evidence:</u> Refer to intrinsic evidence cited in support of the claim terms: "physical layer connection"; "negotiated physical layer modulation"; "physical layer modulation"; "based on".</p> <p>Prosecution History: Preliminary Amendment, submitted on March 20, 1997, at pg. 2; First Response With</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>startup and training"; "Synchronize to alternative modulation standard"; or FIG. 5, boxes labeled "Clqck signal received within two seconds," "Standard automode, send ans (2100 Hz)," "Send ANSqck (V.34 S signal)," "Perform Modem Startup and Training"; or FIG. 6, boxes labeled "Send Clqck-Central," "ANS detected?," "ETC1 (V.32bis training); "ANSam detected?"; "V.34 startup," "ANSqck detected (1680)," "Startup under alternative standard"; or FIG. 7, boxes labeled "CI of V.34 detected," "V.34 send ANSam," "Clctc1 detected," "ETC1 mode, send 'ans,'" "Clqck-cell detected (1500 & 1900)," "Send ANSqck-PSTN," "Send ANSqck (V.34 S signal) (1680 Hz)," "ETC2 Startup (Send S signal)."</p> <p><u>Intrinsic evidence</u></p> <p>Abstract, FIGS 1-9; 1:23-2:39; 2:62-3:15; 3:31-62; 4:5-18; 5:42-11:27; 13:42-14:19; claims 1, 2, 6, 7, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23, 1998.</p> <p><u>Extrinsic evidence</u></p> <p>Testimony of Dr. V. Thomas Rhyme regarding the structures corresponding to the recited function.</p>	<p>Amendments, submitted on October 23, 1997, at pgs. 5-13; Response to Final Rejection, submitted on January 23, 1998, at pgs. 2-10; Third Response, submitted on April 23, 1998, at pg. 3; Transmittal of New Drawings, submitted on July 27, 1998; Notice of Allowability.</p> <p><u>Extrinsic Evidence:</u></p> <p>Extrinsic evidence cited above relating to component terms.</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
<p>means for establishing said link layer connection based upon said negotiated physical layer modulation (claim 6)</p>	<p>Rembrandt incorporates by reference its intrinsic and extrinsic support for the claim terms: "physical layer"; "negotiated physical layer modulation"; "physical layer modulation"; and "establishing said link layer connection based upon said negotiated physical layer modulation."</p> <p><u>Proposed construction</u> Interpreted under 35 U.S.C. § 112, ¶ 6.</p> <p>Function: Establishing the link layer connection based upon the negotiated physical layer modulation</p> <p>Structure: a modem configured to establish the link layer connection based upon the negotiated physical layer modulation, or the equivalent</p> <p>In the event the Court holds that the structure corresponding to the recited function must be an algorithm, Rembrandt designates the following alternative structures: 11:39-46; 13:34-37.</p> <p><u>Intrinsic evidence</u> Abstract; FIGS. 1-9; 1:23-61; 2:40-59; 2:62-3:15; 3:31-62; 4:5-18; 11:30-14:19; claims 1, 3, 4, 6, 7, 9, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23,</p>	<p>Means plus function claim to be construed pursuant to § 112, ¶ 6.</p> <p><u>Function:</u> Establishing link layer connection based upon negotiated physical layer modulation.</p> <p><u>Structure:</u> Figs. 8-9; Col. 12, Ln. 55-Col. 13, Ln. 17; Col. 13, Lns. 34-41; Col. 13, Ln. 55-Col. 14, Ln. 9.</p> <p><u>Intrinsic Evidence:</u> Refer to intrinsic evidence cited in support of the claim terms: "negotiated physical layer modulation"; "physical layer modulation"; "based upon"; "link layer connection".</p> <p>Prosecution History: Preliminary Amendment, submitted on March 20, 1997, at pg. 2; First Response With Amendments, submitted on October 23, 1997, at pgs. 5-13; Response to Final Rejection, submitted on January 23, 1998, at pgs. 2-10; Third Response, submitted on April 23, 1998, at pg. 3; Transmittal of New Drawings, submitted on July 27, 1998; Notice of Allowability.</p> <p><u>Extrinsic Evidence:</u> Extrinsic evidence cited above relating to component terms.</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>1998.</p> <p><u>Extrinsic evidence:</u></p> <p>Testimony of Dr. V. Thomas Rhyme regarding the structures corresponding to the recited function.</p>	<p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.</p>
<p>means for presetting link layer parameters of said link layer connection to pre-defined settings based on said negotiated physical layer modulation (claim 9)</p>	<p><u>Proposed construction</u></p> <p>Interpreted under 35 U.S.C. § 112, ¶ 6.</p> <p>Function: Presetting link layer parameters based on the negotiated physical layer modulation</p> <p>Structure: a modem configured to preset link layer parameters of the link layer connection to pre-defined settings based on the negotiated physical layer modulation, or the equivalent</p> <p>In the event the Court holds that the structure corresponding to the recited function must be an algorithm, Rembrandt designates the following alternative structures: 11:39-46; 13:34-37.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract; FIGS. 1-9; 1:23-61; 2:40-59; 2:62-3:15; 3:31-62; 4:5-18; 11:30-14:19; claims 1, 3, 4, 6, 7, 9, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998</p>	<p>Means plus function claim to be construed pursuant to § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Presetting link layer parameters based on negotiated physical layer modulation.</p> <p><u>Structure:</u></p> <p>Figs. 8-9; Col. 12, Ln. 55-Col. 13, Ln. 17; Col. 13, Lns. 34-41; Col. 13, Ln. 55-Col. 14, Ln. 9.</p> <p><u>Intrinsic Evidence:</u> Refer to intrinsic evidence cited in support of the claim terms: "link layer parameters"; "negotiated physical layer modulation"; "physical layer modulation"; "based on"; "link layer connection";</p> <p>Prosecution History: Preliminary Amendment, submitted on March 20, 1997, at pg. 2; First Response With Amendments, submitted on October 23, 1997, at pgs. 5-13; Response to Final Rejection, submitted on January 23, 1998, at pgs. 2-10; Third Response, submitted on April 23, 1998, at pg. 3; Transmittal of New Drawings, submitted on July 27, 1998; Notice of Allowability.</p> <p><u>Extrinsic Evidence:</u></p> <p>Extrinsic evidence cited above relating to component terms.</p>

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'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	(TKHR0000136-TKHR0000143); Response of April 23, 1998. <u>Extrinsic evidence</u> Testimony of Dr. V. Thomas Rhyme regarding the structures corresponding to the recited function.	Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.

United States Patent No. 4,937,819

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
application program[s] (claims 1, 14)	<p><u>Proposed construction</u> a computer program or process</p> <p><u>Intrinsic Evidence</u> Abstract; FIG. 5; 1:7-12; 1:14-25; 1:45-52; 1:56-62; 2:5-10; 2:26-34; 3:12-19; 4:53-61; 5:59-68; 6:49-51</p> <p><u>Extrinsic Evidence</u> The New IEEE Standard Dictionary of Electrical and Electronics Terms (5th Ed.)(1993)(definition of "application program") Newton's Telecom Dictionary (7th Ed.)(1991)(definition of "application" and "program") 11/7/06 Deposition of Wayne Moore (rough transcript) at 84:13-24 11/8/06 Deposition of Joseph King (rough transcript) at 39:10-43:12; 53:17-54:23; 55:18-57:6; 58:23-59:3; 125:8-126:17</p>	<p>A program designed to assist in the performance of a specific end-user task (e.g., word processing, accounting, or inventory management) in contrast to a program designed to perform management of or maintenance work on the system or system components.</p> <p><u>Intrinsic Evidence:</u></p> <p>'819 Patent Abstract; Figs. 2, 4-5; columns and lines 1:7-12; 1:14-33; 1:45-2:34; 2:56-60; 3:12-19; 3:21-24; 3:39-41; 3:50-56; 4:39-52; 4:55-61; 5:10-13; 5:24-26; 5:64-68; 6:43-48; 6:49-51; 6:66-67.</p> <p>'819 Prosecution History 9/26/88 Patent Application at 15-18 (REM 0055943-55946). 5/20/89 Office Action at 2 (REM 0055992). 8/30/89 Amendment at 2-4, 6 (REM 0056095-56097, 56099). 10/13/89 Office Action at 4 (REM 0056108). U.S. Patent No. 4,606,023 (Dragoo) (REM 0055999-56007). U.S. Patent No. 4,644,534 (Sperlich) (REM 0056112-56119).</p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>U.S. Patent No. 4,726,017 (Krum) (REM 0055979-55989).</p> <p><u>Extrinsic Evidence:</u></p> <p>MICROSOFT COMPUTER DICTIONARY 33 (5th ed. 2002) ("application program").</p> <p>MICROSOFT COMPUTER DICTIONARY 31 (5th ed. 2002) ("application").</p> <p>MICROSOFT COMPUTER DICTIONARY 544 (5th ed. 2002) ("utility").</p> <p>MICROSOFT COMPUTER DICTIONARY 544 (5th ed. 2002) ("utility program").</p> <p>WEBOPEDIA, available at http://www.webopedia.com/TERM/a/application.html (last visited Oct. 13, 2006) ("application").</p> <p>11/8/06 Deposition of Joseph King, at 39:10 – 43:12; 53:17 – 54:23; 125:8 – 126:15 (based on rough transcript)</p> <p>Expert opinion of Dr. Curtis Siller regarding what one of ordinary skill in the art would understand this claim term to mean.</p>
dividing a period of a clock in said master unit into a number of subframes, dividing each subframe into a number of slots, each corresponding to transmission times for one	<p><u>Proposed construction</u></p> <p>Ordinary meaning</p> <p><u>Intrinsic Evidence</u></p> <p>FIG. 5; 4:53-61; 5:10-23; 6:37-39; 6:49-51; claim 15</p> <p>11/8/06 Deposition of Joseph King (rough transcript) at</p>	<p>Dividing the network clock period into time units (subframes), each of which is used for transmission by a specified remote; and dividing each subframe into smaller time units (time slots), each of which is assigned at initialization to one application via non-packetized messages from the master.</p>

‘819 Patent Claim Terms	Plaintiff Rembrandt’s Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast’s Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
of said remote units, and assigning a slot to each of said application programs (claim 14)	54:24-67:19; 81:5-81:11; 107:19-119:16; 133:7-134:21	<p><u>Intrinsic Evidence:</u></p> <p>‘819 Patent</p> <p>Abstract; Figs. 1, 3, 5-7; columns and lines 1:45-2:34; 2:44-49; 2:60-3:24; 3:59-65; 4:53-5:67; 6:37-39; 6:49-57; 6:66-7:2; 7:11-14; 7:22-25; 7:40-44; 8:18-24.</p> <p>‘819 Prosecution History</p> <p>9/26/88 Patent Application at 15-18 (REM 0055943-55946).</p> <p>5/20/89 Office Action at 3-7 (REM 0055993-55997).</p> <p>8/30/89 Amendment at 2-4, 7-11 (REM 0056095-56097, 56100-56104).</p> <p>10/13/89 Office Action at 3-6 (REM 0056107-56110).</p> <p>2/13/90 Amendment at 2-7 (REM0056173-56178).</p> <p>U.S. Patent No. 4,644,534 (Sperlich) (REM 0056112-56119).</p> <p>U.S. Patent No. 4,726,017 (Krum) (REM 0055979-55989).</p> <p><u>Extrinsic Evidence</u></p> <p>11/8/06 Deposition of Joseph King at 54:24 – 55:8; 59:17 – 63:7; 66:22 – 67:19; 117:8 – 119:9.</p>
time slot assigned to each of said application programs (claim 1)	<p><u>Proposed construction</u></p> <p>“time slot” means an interval of time during which data from an application program is transmitted; rest of</p>	<p>An interval of time is assigned at initialization to each application program.</p> <p><u>Intrinsic Evidence:</u></p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
reservation request generator (claim 2)	<p>limitation is ordinary meaning</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract; 1:45-2:33; 2:68-3:11; 3:59-65; 4:53-66; 5:14-23; 5:40-56; 6:49-57; 6:66-7:14</p> <p><u>Extrinsic Evidence</u></p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (5th Ed.)(1993)(definition of "timeslot")</p> <p>The Computer Glossary (6th Ed.)(1993)(definition of "time slot")</p> <p>Newton's Telecom Dictionary (7th Ed.)(1991)(definition of "time slot")</p> <p>11/8/06 Deposition of Joseph King (rough transcript) at 54:24-67:19; 81:5-81:11; 107:19-119:16; 133:7-134:21</p>	<p>'819 Patent</p> <p>Abstract; Figs. 1, 3, 5-7; columns and lines 1:45-2:34; 2:44-49; 2:60-3:24; 3:59-65; 4:53-5:67; 6:37-39; 6:49-57; 6:66-7:2; 7:11-14; 7:22-25; 7:40-44; 8:18-24.</p> <p>'819 Prosecution History</p> <p>9/26/88 Patent Application at 15-18 (REM 0055943-55946).</p> <p>5/20/89 Office Action at 3-7 (REM 0055993-55997).</p> <p>8/30/89 Amendment at 2-4, 7-11 (REM 0056095-56097, 56100-56104).</p> <p>10/13/89 Office Action at 3-6 (REM 0056107-56110).</p> <p>2/13/90 Amendment at 2-7 (REM0056173-56178).</p> <p>U.S. Patent No. 4,644,534 (Sperlich) (REM 0056112-56119).</p> <p>U.S. Patent No. 4,726,017 (Krum) (REM 0055979-55989).</p> <p><u>Extrinsic Evidence</u></p> <p>11/8/06 Deposition of Joseph King at 54:24 – 55:8; 59:17 – 63:7; 66:22 – 67:19; 117:8 – 119:9.</p> <p>At this time, Comcast does not believe this term requires construction, but provides the following proposed construction in response to Rembrandt's request to construe the term.</p> <p>A device or process that monitors messages from the</p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>Abstract; Figs. 2 & 4, element 54; 1:63-2:1; 2:18-26; 4:3-14; 4:53-61; 5:59-6:24; 6:66-:14</p> <p>11/8/06 Deposition of Joseph King (rough transcript) at 133:7-134:21.</p>	<p>remote units to the master unit and sets reservation bits in them, if any of their fields exceeds a preset parameter limit.</p> <p><u>Intrinsic Evidence:</u></p> <p>'819 Patent</p> <p>Abstract; Figs. 8-9; columns and lines 1:45-2:34; 2:18-25; 2:50-51; 2:61-68; 3:7-11; 3:35-37; 3:59-65; 4:6-16; 4:57-61; 4:64-67; 5:57-6:24; 6:11-6:24; 6:57-63; 6:66-7:14.</p> <p><u>Extrinsic Evidence:</u></p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 912 (6th ed. 1996) ("request message") (sole definition).</p>
<p>reservation request processor (claim 2)</p>	<p><u>Proposed construction</u></p> <p>a device or process for receiving and processing requests for additional time slots from a reservation request generator</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract; Figs. 1 & 3, element 14; 1:63-2:1; 2:18-26; 3:7-11; 4:53-61; 5:59-6:24; 6:66-7:14</p> <p>11/8/06 Deposition of Joseph King (rough transcript) at 133:7-134:21.</p>	<p>At this time, Comcast does not believe this term requires construction, but provides the following proposed construction in response to Rembrandt's request to construe the term.</p> <p>A device or process that can grant a request from a remote unit for more time slots in order for the remote unit to transmit a longer message.</p> <p><u>Intrinsic Evidence:</u></p> <p>'819 Patent</p> <p>Abstract; Figs. 8-9; columns and lines 1:45-2:34; 2:18-25; 2:50-51; 2:61-68; 3:7-11; 3:35-37; 3:59-65; 4:6-16; 4:57-61; 4:64-67; 5:57-6:24; 6:11-6:24; 6:57-63; 6:66-7:14.</p> <p><u>Extrinsic Evidence:</u></p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 912 (6th ed. 1996) ("request message") (sole definition).
priority bit (claim 11)	<p><u>Proposed construction</u></p> <p>One or more communication bits that are used to convey the relative importance of the communication</p> <p><u>Intrinsic Evidence</u></p> <p>FIG. 5; 1:63-2:1; 2:18-26; 2:68-3:6; 4:62-5:3; 5:10-23; 5:40-45; 5:59-6:24; 6:52-7:14</p> <p><u>Extrinsic Evidence</u></p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (5th Ed.)(1993)(definition of "priority")</p> <p>Von Nostrand's Dictionary of Information Technology (3rd Ed.)(1989)(definition of "priority")</p> <p>Newton's Telecom Dictionary (7th Ed.)(1991)(definition of "priority")</p>	<p>A bit that defines the importance of a given remote unit relative to other remote units.</p> <p><u>Intrinsic Evidence:</u></p> <p>'819 Patent</p> <p>Abstract; Figs. 5-9; columns and lines 1:45-2:34; 2:66-3:6; 4:62-5:24; 5:39-45; 5:53-6:24; 6:1-10; 6:53-7:14.</p>
master network timing means with a period which is divided into a plurality of subframes, wherein each subframe is divided into said time slots, and each of said time slots is used as an interval in	<p><u>Proposed construction</u></p> <p>"master network timing means" is a clock for determining network timing or for delineating time into time slots; rest of limitation is construed according to ordinary meaning</p> <p><u>Intrinsic Evidence</u></p> <p>claim 10; FIGS. 1 & 3, element 12; 2:60-3:6; 5:15-24;</p>	<p>This is a means-plus-function term subject to construction under 35 U.S.C. § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Dividing the period into subframes, and the subframes further into time slots, and assigning a time slot to each application.</p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
<p>which one of said application programs in said one of said remote units is assigned to transmit (claim 1)</p>	<p>6:32-42; claim 3</p> <p><u>Extrinsic Evidence</u></p> <p>Von Nostrand's Dictionary of Information Technology (3rd Ed.)(1989)(definition of "master clock")</p> <p>McGraw-Hill Dictionary of Scientific and Technologic Terms (4th Ed.)(1989) (definition of "master clock")</p> <p>The Computer Glossary (6th Ed.)(1993)(definition of "master clock")</p> <p>Newton's Telecom Dictionary (7th Ed.)(1991)(definition of "master clock")</p> <p>11/8/06 Deposition of Joseph King (rough transcript) at 54:24-67:19; 81:5-81:11; 107:19-119:16; 133:7-134:21</p> <p>Testimony of Dr. V. Thomas Rhynne regarding the meaning of this claim term</p> <p>Rembrandt does not believe this limitation is subject to construction under 35 U.S.C. § 112, ¶ 6. Nonetheless, Rembrandt reserves the right to argue that should this limitation be governed by § 112, ¶ 6, it should be construed as follows:</p> <p>Function: determining master network timing</p> <p>Structure: FIGS. 1 & 3, element 12; 2:60-3:6; 5:15-24; 6:32-42</p>	<p><u>Structure:</u></p> <ul style="list-style-type: none"> Network Timing Control Processor 12. See '819 Patent at Figs. 1, 3; 2:60-3:6; 3:12-24; 5:15-24; 5:29-34. <p><u>Intrinsic Evidence:</u></p> <p>'819 Patent</p> <p>Abstract; Figs. 1, 3, 5-9; columns and lines 1:45-2:34; 2:44; 2:66-3:24; 3:59-65; 4:53-6:24; 6:37-39; 6:49-7:14; 7:22-25; 7:40-44.</p> <p>8/30/89 Amendment at 2, 8-9 (REM 0056095, 56101-56102).</p> <p>10/13/89 Office Action at 2-4 (REM 0056106-56108).</p> <p>2/13/90 Amendment at 2, 6-7 (REM 0056173, 56177-56178).</p> <p>U.S. Patent No. 4,644,534 (Sperlich) (REM 0056112-56119).</p> <p><u>Extrinsic Evidence:</u></p> <p>Expert opinion of Dr. Curtis Siller regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.</p> <p>11/8/06 Deposition of Joseph King at 81:5 – 82:2.</p>
<p>ranging means communicating with said</p>	<p><u>Proposed construction</u></p>	<p>This is a means-plus-function term subject to construction</p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
<p>master network timing means wherein a transmission time between said master unit and each of said respective remote units is calculated and transmitted from said master unit to each of said respective remote units (claim 1)</p>	<p>"ranging means" is a device or process that determines a transmission time between the master unit and a remote unit; rest of limitation is construed according to ordinary meaning</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract; FIGS 1 & 3, elements 12, 20, 32; 1:63-2:17; 2:57-3:6; 3:25-29; 3:42-49; 4:62-5:3; 5:24-34; 6:32-36</p> <p><u>Extrinsic evidence</u></p> <p>Testimony of Dr. V. Thomas Rhyme regarding the meaning of this claim term</p> <p>11/8/06 Deposition of Joseph King (rough transcript) at 69:5-10</p> <p>Rembrandt does not believe this limitation is subject to construction under 35 U.S.C. § 112, ¶ 6. Nonetheless, Rembrandt reserves the right to argue that should this limitation be governed by § 112, ¶ 6, it should be construed as follows:</p> <p>Function: (performing) ranging</p> <p>Structure: FIGS 1 & 3, elements 12, 20, 32; 1:63-2:17; 2:57-3:6; 3:25-29; 3:42-49; 4:62-5:3; 5:24-34; 6:32-36;</p>	<p>under 35 U.S.C. § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Calculating and transmitting to each remote the time it takes to transmit between the master and that remote.</p> <p><u>Structure:</u></p> <ul style="list-style-type: none"> • Network Timing and Control Processor 12. See '819 Patent at Figs. 1, 3; 3:12-24; 5:14-33. • Aggregate Rate Multiplexer 16. See '819 Patent at Figs. 1, 3; 3:12-24. • Ranging and Network Initialization Generator 20. See '819 Patent at Figs. 1, 3; 3:12-19. • Time Division Multiplexed Modulator 22. See '819 Patent at Figs. 1, 3; 3:19-24; 3:50-52. • Equalizer 24. See '819 Patent at Figs. 1, 3; 3:30-33; 4:17-18; 4:20-26; 5:34-38. • Automatic gain control 26. See '819 Patent at Figs. 1, 3; 3:33-34; 4:20-31; 5:34-38. • Demodulator 28. See '819 Patent at Figs. 1, 3; 3:33-38. • Ranging receiver 32. See '819 Patent at Figs. 1, 3; 3:35-38; 3:42-45; 4:20-26. <p><u>Intrinsic Evidence:</u></p> <p>'819 Patent</p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>Abstract; Figs. 1, 3, 7; columns and lines 1:45-2:34; 3:12-38; 3:42-45; 3:50-52; 3:65-4:2; 4:17-18; 4:20-31; 5:1-3; 5:14-56; 5:46-52; 6:32-36.</p> <p>'819 Prosecution History</p> <p>9/26/88 Patent Application at 15-18 (REM 0055943-55946).</p> <p>5/20/89 Office Action at 2, 4-5 (REM 0055992, 55994-55995).</p> <p>8/30/98 Amendment at 2, 6, 8-10 (REM 0056095, 56099, 56101-56103).</p> <p>10/13/89 Office Action at 2-4 (REM 0056106-56108).</p> <p>2/13/90 Amendment at 2, 6-7 (REM 0056173, 56177-56178).</p> <p>U.S. Patent No. 4,606,023 (Dragoo) (REM 0055999-56007).</p> <p>U.S. Patent No. 4,644,534 (Sperlich) (REM 0056112-56119).</p> <p>U.S. Patent No. 4,726,017 (Krum) (REM 0055979-55989).</p> <p><u>Extrinsic Evidence:</u></p> <p>Expert opinion of Dr. Curtis Siller regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.</p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
<p>means for calculating clock drifts of the remote units and issuing reset commands to correct the same (claim 12)</p>	<p>Interpreted under 35 U.S.C. § 112, ¶ 6.</p> <p>Function: determining a drift time between the master clock and a remote clock and issuing one or more commands to correct the drift</p> <p>Structure: FIGS. 1 & 3, element 12; 2:57-68; 3:25-29; 7:15-20</p> <p><u>Extrinsic evidence</u></p> <p>Testimony of Dr. V. Thomas Rhynne regarding the structures corresponding to the recited function</p>	<p>This is a means-plus-function term subject to construction under 35 U.S.C. § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Determining any differences or skew between the master clock and the respective clock maintained by each remote unit, and issuing one or more commands to correct the drift.</p> <p><u>Structure:</u></p> <p>The patent specification does not disclose any structure corresponding to the "means for calculating clock drifts."</p> <p><u>Intrinsic Evidence:</u></p> <p>'819 Patent</p> <p>Abstract; Fig. 8; columns and lines 1:45-2:34; 2:61-68; 3:25-29; 5:1-3; 7:15-20.</p> <p>'819 Prosecution History</p> <p>8/30/98 Amendment at 4, 6 (REM 0056097, 56099).</p> <p><u>Extrinsic Evidence:</u></p> <p>Expert opinion of Dr. Curtis Siller regarding whether one of ordinary skill in the art would understand the patent specification to disclose any structures corresponding to this means-plus-function claim term.</p> <p>11/8/06 Deposition of Joseph King at 81:5 – 82:2.</p>

United States Patent No. 5,719,858

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
<p>time-division multiplexed bus (claims 1, 7, 9, 11, 15, 20)</p>	<p><u>Proposed construction</u> a bus having a bandwidth partitioned into regular time slots and bit-time slots, that is shared by two or more sources of data by limiting each source's transmission opportunities to discrete intervals of time</p> <p><u>Intrinsic Evidence</u> FIGS. 3 & 4, element 204; FIGS. 5 & 7; Abstract; 2:42-65; 3:39-61; 4:25-36; 5:43-6:5; 6:36-41; 6:52-64; 11:12-17</p> <p><u>Extrinsic Evidence</u> Dictionary of Computing (4th Ed.)(1996)(definition of "time division multiplexing") 11/8/06 Deposition of Joseph King (rough transcript) at 49:9-52:11</p>	<p>A group of one or more conductors that is shared among several users by allowing each user to use the bus for a given period of time in a defined, repeated sequence.</p> <p><u>Intrinsic Evidence:</u> '858 Patent Abstract; Figs. 1-3, 5-7; columns and lines 1:6-12; 1:28-64; 2:15-39; 2:41-3:12; 3:25-27; 3:39-61; 4:25-36; 4:47-51; 4:56-6:5; 6:37-8:45; 9:17-38; 10:43-57; 11:3-37. '858 Prosecution History 7/31/95 Patent Application at 15-18 (REM 0056495-56498). 4/4/97 Office Action at 2-4 (REM 0056522-56524). 8/1/97 Amendment and Response to Office Action at 2-12 (REM 0056633-56643). 10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648). U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551). <u>Extrinsic Evidence:</u> IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 1115 (6th ed. 1996) ("time division multiplexing (TDM)") (1st definition).</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 117 (6th ed. 1996) ("bus") (3rd definition).</p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).</p> <p>Expert opinion of Dr. Curtis Siller regarding what one of ordinary skill in the art would understand this claim term to mean.</p>
<p>portion of the [predefined] bandwidth (claims 1, 7, 9, 11, 15, 20)</p>	<p><u>Proposed construction</u> one or more time slots in a TDM frame assigned to a group of data sources; see below for "predefined bandwidth"</p> <p><u>Intrinsic Evidence</u> Abstract; 2:49-57; 4:56-62; 5:11-42; 6:15-24; 11:12-17</p>	<p>The part, but less than all, of the data transfer capacity of the bus that is allotted either to packet data or to synchronous data.</p> <p><u>Intrinsic Evidence:</u></p> <p>'858 Patent Abstract; Figs. 1-3, 5-7; columns and lines 1:6-3:12; 3:39-53; 4:37-5:42; 6:6-52; 11:3-37.</p> <p>'858 Prosecution History 7/31/95 Patent Application at 15-18 (REM 0056495-56498). 4/4/97 Office Action at 2-5 (REM0056522-56525). 8/1/97 Amendment and Response to Office Action at 2-12</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>(REM 0056633-56643).</p> <p>10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648).</p> <p>U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p><u>Extrinsic Evidence:</u></p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 905 (10th ed. 1993) ("portion") (1st and 3rd definitions).</p> <p>MICROSOFT COMPUTER DICTIONARY 50 (5th ed. 2002) ("bandwidth") (2nd definition).</p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).</p>
<p>predefined bandwidth (claims 7, 9, 11)</p>	<p><u>Proposed construction</u></p> <p>a TDM frame with a fixed number of time slots</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract; 2:49-57; 4:56-62; 5:11-42; 6:15-24; 11:12-17</p>	<p>Data transfer capacity fixed in advance of operation.</p> <p><u>Intrinsic Evidence:</u></p> <p>'858 Patent</p> <p>Abstract; Figs. 1-3, 5-7; columns and lines 1:6-3:12; 3:39-53; 4:37-5:42; 6:6-52; 11:3-37.</p> <p>'858 Prosecution History</p> <p>7/31/95 Patent Application at 15-18 (REM 0056495-</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>56498).</p> <p>4/4/97 Office Action at 2-5 (REM00565222-56525).</p> <p>8/1/97 Amendment and Response to Office Action at 2-12 (REM 0056633-56643).</p> <p>10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648).</p> <p>U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p><u>Extrinsic Evidence:</u></p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 913 (10th ed. 1993) ("pre-") (1st definition).</p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 302 (10th ed. 1993) ("define") (2nd definition).</p> <p>MICROSOFT COMPUTER DICTIONARY 50 (5th ed. 2002) ("bandwidth") (2nd definition).</p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).</p>
packet data (claims 1, 7, 9, 11, 15, 20)	<p><u>Proposed construction</u></p> <p>variable bit rate data</p>	<p>Data that is transmitted in packets.</p> <p><u>Intrinsic Evidence:</u></p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p><u>Intrinsic Evidence</u> Abstract; 1:6-11; 1:17-26; 3:53-56</p> <p><u>Extrinsic Evidence</u> Newton's Telecom Dictionary (7th Ed.)(1994)(definition of "VBR") Longman Illustrated Dictionary of Computer Science (1987) (definition of "asynchronous") Acampora at 2:22-32 COMREM976690-977133 11/7/06 Deposition of Wayne Moore (rough transcript) at 41:19-22</p>	<p>'858 Patent Abstract; Figs. 1-3, 5; columns and lines 1:6-11; 1:17-23; 1:28-29; 1:34-39; 2:41-3:12; 3:39-51; 4:4-6; 4:11-17; 4:19-28; 4:39-55; 4:56-5:42; 6:15-24; 6:34-36; 6:44-50; 7:13-20; 9:63-10:2; 10:11-30; 11:3-37; 12:20-29; 12:62-13:1.</p> <p>'858 Prosecution History 7/31/95 Patent Application at 15-18 (REM 0056495-56498). 4/4/97 Office Action at 2-4 (REM 0056522-56524). 8/1/97 Amendment and Response to Office Action at 2-12 (REM 0056633-56643). 10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648). U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551). U.S. Patent No. 5,463,624 (Hogg) (REM 0056585-56612).</p> <p><u>Extrinsic Evidence:</u> IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 740 (6th ed. 1996) ("packet") (1st definition). IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 740 (6th ed. 1996) ("packet") (3rd definition). IEEE STANDARD DICTIONARY OF ELECTRICAL AND</p>

‘858 Patent Claim Terms	Plaintiff Rembrandt’s Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast’s Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>ELECTRONICS TERMS 740 (6th ed. 1996) (“packet”) (6th definition).</p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 740 (6th ed. 1996) (“packet”) (7th definition).</p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 740 (6th ed. 1996) (“packet”) (10th definition).</p> <p>MICROSOFT COMPUTER DICTIONARY 385 (5th ed. 2002) (“packet”) (2nd definition).</p> <p>Wayne Moore, “An Approach for Packet Transport in the MAC system” (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, “A Method for Packet Transport in the MAC system” (4/8/94) (memorandum) (REM 0085210-85213).</p>
synchronous data (claims 7, 9, 11)	<p><u>Proposed construction</u> constant bit rate data</p> <p><u>Intrinsic Evidence</u> Abstract; 1:6-11; 1:17-26; 3:48-51</p> <p><u>Extrinsic Evidence</u> Newton’s Telecom Dictionary (7th Ed.)(1994)(definitions of “synchronous”, “synchronous data network”, “CBR”) Dictionary of Computing (4th Ed.)(1996)(definition of</p>	<p>Constant bit rate data that is not transmitted in packets.</p> <p><u>Intrinsic Evidence:</u></p> <p>‘858 Patent Abstract; Figs. 1-3, 5; columns and lines 1:6-11; 1:17-23; 1:28-29; 1:34-39; 2:41-3:12; 3:39-51; 4:4-6; 4:11-17; 4:19-28; 4:39-55; 4:56-5:42; 6:15-24; 6:34-36; 6:44-50; 7:13-20; 9:63-10:2; 10:11-30; 11:3-37; 12:20-29; 12:62-13:1.</p> <p>‘858 Prosecution History</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>"time division multiplexing")</p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (5th Ed.)(1993)(definition of "synchronous")</p> <p>Longman Illustrated Dictionary of Computer Science (1987) (definition of "synchronous")</p> <p>Von Nostrand Reinhold Dictionary of Information Technology (3rd Ed.)(1989)(definitions of "synchronous", "synchronous data network", "synchronous modem", "synchronous time division multiplexing", "synchronous transmission")</p> <p>Acampora at 2:22-32</p> <p>11/7/06 Deposition of Wayne Moore (rough transcript) at 41:14-18; 77:23-78:24</p>	<p>7/31/95 Patent Application at 15-18 (REM 0056495-56498).</p> <p>4/4/97 Office Action at 2-4 (REM 0056522-56524).</p> <p>8/1/97 Amendment and Response to Office Action at 2-12 (REM 0056633-56643).</p> <p>10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648).</p> <p>U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p>U.S. Patent No. 5,463,624 (Hogg) (REM 0056585-56612).</p> <p><u>Extrinsic Evidence:</u></p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 1075 (6th ed. 1996) ("synchronous") (1st definition).</p> <p>MICROSOFT COMPUTER DICTIONARY 38 (5th ed. 2002) ("asynchronous") (sole definition).</p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).</p>
distributed packet manager	<u>Proposed construction</u> a device, process or algorithm that is located within each	A decentralized mechanism that performs all the functions required to aggregate and synchronize packet data to the

‘858 Patent Claim Terms (claims 1, 7)	Plaintiff Rembrandt’s Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast’s Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>packet data source, that controls how the packet data source accesses a portion of the bandwidth assigned to packet data, and that accepts an entire packet stream from a network access module to obtain data addressed to the packet data source</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract; FIG. 3, elements 216-n; FIG. 4, PACKET MANAGER; FIG. 6; FIG. 8; 2:53-3:12, 3:51-4:36; 4:56-5:10; 6:6-15; 6:41-10:42</p> <p><u>Extrinsic Evidence</u></p> <p>Von Nostrand Reinhold Dictionary of Information Technology (3rd Ed.)(1989)(definition of “distributed function”)</p> <p>Dictionary of Computer and Internet Terms (5th Ed.)(1996)(definition of “distributed”)</p> <p>The Computer Glossary (6th Ed.)(1993)(definition of “distributed function”)</p> <p>11/7/06 Deposition of Wayne Moore (rough transcript) at 177:11-178:20</p>	<p>time-division multiplexed bus and to prevent packet collisions.</p> <p><u>Intrinsic Evidence:</u></p> <p>‘858 Patent</p> <p>Abstract; Figs. 1-4, 8A-8C; columns and lines 1:6-3:12; 3:23-24; 3:34-36; 3:51-4:36; 4:56-5:10; 6:6-10:43.</p> <p>‘858 Prosecution History</p> <p>8/1/97 Amendment and Response to Office Action at 2-12 (REM0056633-56643).</p> <p>10/1/97 Examiner’s Statement of Reasons for Allowance at 1 (REM 0056648).</p> <p>U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p>U.S. Patent No. 5,463,624 (Hogg) (REM 0056585-56612).</p> <p><u>Extrinsic Evidence:</u></p> <p>Wayne Moore, “An Approach for Packet Transport in the MAC system” (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, “A Method for Packet Transport in the MAC system” (4/8/94) (memorandum) (REM 0085210-85213).</p>
allocate access to the allotted bandwidth among said packet data sources	<p><u>Proposed construction</u></p> <p>Controlling access by each of the packet data sources to</p>	<p>Apportion to each of the packet data sources sole permission to attempt to transmit in any one or more of the</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
<p>(claim 1)</p> <p>allocate access to the second portion of the predefined bandwidth among said packet data sources</p> <p>(claim 7)</p> <p>controlling [the] access by said packet data sources to the allocated portion of the bandwidth</p> <p>(claims 15, 20)</p>	<p>the portion of bandwidth previously assigned to packet data</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract; FIGS. 6 & 8, 2:49-57; 2:66-3:3; 4:56-5:5; 6:6-14; 6:41-10:42</p> <p><u>Extrinsic Evidence</u></p> <p>Van Nostrand Reinhold Dictionary of Information Technology (3rd Ed.)(1989)(definition of "allocate")</p> <p>The Computer Glossary (6th Ed.)(1993)(definition of "allocate")</p> <p>Longman Illustrated Dictionary of Computer Science (1987) (definition of "allocate")</p> <p>11/7/06 Deposition of Wayne Moore (rough transcript) at 177:11-178:20</p>	<p>specified time slots allotted to packet data.</p> <p><u>Intrinsic Evidence:</u></p> <p>'858 Patent</p> <p>Abstract; Figs. 1-4, 8A-8C; columns and lines 1:6-3:12; 3:23-24; 3:34-36; 3:51-4:36; 4:56-5:10; 5:11-20; 5:30-32; 6:6-10:43.</p> <p>'858 Prosecution History</p> <p>8/1/97 Amendment and Response to Office Action at 2-12 (REM0056633-56643).</p> <p>10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648).</p> <p>U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p>U.S. Patent No. 5,463,624 (Hogg) (REM 0056585-56612).</p> <p><u>Extrinsic Evidence:</u></p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 30 (10th ed. 1993) ("allocate") (1st definition).</p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 6 (10th ed. 1993) ("access") (2nd definition).</p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 252 (10th ed. 1993) ("control") (2nd definition).</p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		85209). Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).
network access manager (claim 8) network access module (claim 26)	<p><u>Proposed construction</u></p> <p>a device, process or algorithm for controlling the assignment of synchronous and packet data portions on a TDM bus, and for passing data between the bus and a network</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract; FIG. 3, element 205; 1:12-26; 2:49-65; 3:39-48; 4:62-5:2; 5:11-20; 9:22-30;</p>	At this time Comcast does not believe this term needs to be construed, but reserves its right to argue its ordinary meaning and to counter Rembrandt's proposed construction.

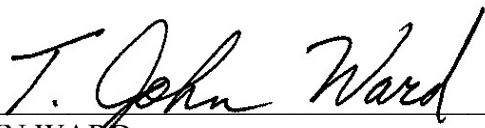
IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANT TECHNOLOGIES, LP	§	
Vs.	§	CIVIL ACTION NO. 2:05CV443
COMCAST CORP., ET AL.	§	

ORDER

The parties' agreed motion to set briefing schedule (#76) is granted.

SIGNED this 16th day of November, 2006.



T. JOHN WARD
UNITED STATES DISTRICT JUDGE

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

Plaintiff

v.

COMCAST CORPORATION, COMCAST
CABLE COMMUNICATIONS, LLC, and
COMCAST OF PLANO, LP

Defendant

§
§
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§
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§
§
§
§

Civil Action No. 2-05-cv-443-TJW

Jury

**DEFENDANT COMCAST CORPORATION’S SUR-REPLY IN RESPONSE TO
PLAINTIFF’S MOTION FOR CLARIFICATION REGARDING P.R. 3-1(h)**

I. INTRODUCTION

The arguments advanced by Rembrandt in its Reply Brief rest on a fundamental mischaracterization of Comcast’s position, which is described below. For this reason, and those advanced in Comcast’s Response to Rembrandt’s Motion for Clarification, Comcast respectfully requests that the Court order Rembrandt to comply with Local Patent Rule 3-1(h).

II. ARGUMENT

A. Comcast Is Not Seeking Premature Disclosure of Rembrandt’s Expert Reports Or Trial Evidence.

Contrary to Rembrandt’s hyperbole, Comcast is not seeking to “require Rembrandt to finalize its expert analysis of complex source code within thirty days of receipt of each of approximately thirty productions of source code.” (Reply at p. 1) Rather, as explained in its Response, Comcast’s position is the following:

- For claim elements which Rembrandt contends are met solely because a

device implements the relevant standard, and Rembrandt's preliminary infringement contentions ("PICs") provide direct, specific citations to the standard to support Rembrandt's theory of infringement, no supplementation is necessary. Therefore, for example, if Rembrandt already has provided specific allegations regarding how the ATSC and DOCSIS standards allegedly read on the asserted claim elements, Rembrandt need not supplement its PICs every time source code or firmware code merely confirms that a device complies with those standards.

- However, for those claim elements which Rembrandt cannot explain how it contends Comcast infringes of solely by reference to the applicable standard, *e.g.*, because the standard does not address the requirements of the claim element, or because the source code or firmware code shows something additional or different from what the standard provides, then Rembrandt must supplement its PICs with specific citations to the source code.

The critical distinction between these categories is that in the latter, source code is not, as Rembrandt contends, merely "evidence" of infringement. Rather, it forms the basis for Rembrandt's theory of infringement, which Comcast is entitled to know early in the case pursuant to Rules 3-1 and 3-1(h). Rule 3-1 primarily prevents Rembrandt from attempting, without disclosing to Comcast, to prove infringement by some device feature that is found only in source code but not in the standard(s). Allowing Rembrandt that option would eviscerate this Court's P.R. 3-1(h), and unfairly deny Comcast notice of Rembrandt's theory of infringement for all claim elements.

B. Rembrandt Cannot Avoid Rule 3-1(h) Merely Because It Finds The Rule Too Onerous In This Case

The central theme throughout Rembrandt's pleadings is that Rule 3-1(h), if applied literally, would impose too great of a burden on Rembrandt and its consulting experts by forcing them to review multiple batches of source code over time. While Rembrandt frequently exaggerates the magnitude of this burden, the simple fact – to which Rembrandt offered no response in its Reply Brief – is that this is entirely a burden of Rembrandt's own making. Rembrandt chose to sue Comcast, and thereby implicate dozens of Accused Instrumentalities to try to make this the broadest case possible. And because Comcast does not develop or manufacture any of these products, it cannot control the timing by which source code is produced. Had Rembrandt instead chosen to sue one equipment manufacturer with regards to one device, there would be no dispute that Rule 3-1(h) was applicable and that Rembrandt was required to supplement its PICs for those claim elements it contended were met by software limitations within 30 days after receiving the source code for that device. There is no principled reason why the result should be any different here, and in fact Rembrandt cites no authority to the contrary.

Furthermore, in trying to shirk its obligations under Rule 3-1(h), Rembrandt is effectively trying to dump whatever burdens exist onto Comcast by forcing Comcast to defend itself without a clear theory of infringement. Adopting Rembrandt's proposal would leave Comcast in the precarious position of not knowing the specific bases for Rembrandt's infringement contentions until the very end of discovery, when it will be too late for Comcast to adjust its defense in response to those contentions. Rules 3-1 and 3-1(h) are in place to prevent precisely this type of gamesmanship.

III. CONCLUSION

Comcast respectfully requests that the Court order Rembrandt to comply with Local Patent Rule 3-1(h).

Respectfully submitted,

_____/s/ Jennifer Haltom Doan

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**Attorneys for Defendant
COMCAST CORPORATION**

CERTIFICATE OF SERVICE

The undersigned certifies that the foregoing document was filed electronically in compliance with Local Rule CV-5(a). All other counsel of record not deemed to have consented to electronic service were served with a true and correct copy of the foregoing by certified mail, return receipt requested, on this 16th day of November, 2006.

_____/s/ Jennifer Haltom Doan
Jennifer Haltom Doan

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

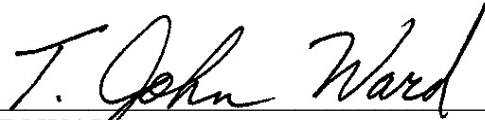
ORDER

The Court, having considered the Joint Motion to Extend the Deadline to Comply with Patent Rule 4-3, concludes that the motion is well taken and should be GRANTED.

Accordingly, it is ORDERED that the new deadline for filing the parties P.R. 4-3 is November 14, 2006.

IT IS SO ORDERED.

SIGNED this 22nd day of November, 2006.



T. JOHN WARD
UNITED STATES DISTRICT JUDGE

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP
Plaintiff,

V.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Defendants.

Civil Action No. 2-05CV-443
Judge T. John Ward

Jury Demand

DEFENDANTS' FIRST AMENDED ANSWER AND COUNTERCLAIMS

Defendants Comcast Corporation, Comcast Cable Communications, LLC (“Comcast Cable”), and Comcast of Plano, LP (collectively, “Comcast”) answer Plaintiff Rembrandt Technologies, LP’s (“Rembrandt”) complaint as follows:

1. Comcast is without sufficient knowledge or information sufficient to form a belief as to the truth of the allegations in this paragraph.

2. Admitted.

3. This paragraph does not require a response.

4. Admitted.

5. Comcast denies that it has committed acts of patent infringement in the Eastern District of Texas. Comcast Corp. and Comcast Cable deny that they are either present or do business in this District and deny that the Court has personal jurisdiction over them. Comcast of Plano, LP admits that this Court has personal jurisdiction.

6. Comcast denies that it has committed acts of patent infringement in the Eastern District of Texas. Comcast Corp. and Comcast Cable deny that they are either present or do business in this District, and also deny that they have minimum contacts with this District.

Comcast Corp. and Comcast Cable therefore deny that venue is proper in this judicial district. Comcast of Plano, LP admits that this Court has personal jurisdiction, and therefore admits that venue is proper in this District.

7. This paragraph does not require a response.

8. Comcast is without sufficient knowledge or information sufficient to form a belief as to the truth of the allegations regarding Rembrandt's ownership and right to enforce U.S. Patent No. 5,243,627 ("the '627 patent").

9. Comcast admits that the United States Patent and Trademark Office issued the '627 patent on September 7, 1993. Comcast is without sufficient knowledge to form a belief as to the truth of whether the '627 patent was "duly and legally issued" because these terms are not defined.

10. Denied.

11. Denied.

12. Denied.

13. This paragraph does not require a response.

14. Comcast is without sufficient knowledge or information sufficient to form a belief as to the truth of the allegations regarding Rembrandt's ownership and right to enforce U.S. Patent No. 5,852,631 ("the '631 patent").

15. Comcast admits that the United States Patent and Trademark Office issued the '631 patent on December 22, 1998. Comcast is without sufficient knowledge to form a belief as to the truth of whether the '631 patent was "duly and legally issued" because these terms are not defined.

16. Denied.

17. Denied.

18. Denied.

19. This paragraph does not require a response.

20. Comcast is without sufficient knowledge or information sufficient to form a belief as to the truth of the allegations regarding Rembrandt's ownership and right to enforce U.S. Patent No. 5,719,858 ("the '858 patent").

21. Comcast admits that the United States Patent and Trademark Office issued the '858 patent on February 17, 1998. Comcast is without sufficient knowledge to form a belief as to the truth of whether the '858 patent was "duly and legally issued" because these terms are not defined.

22. Denied.

23. Denied.

24. Denied.

25. This paragraph does not require a response.

26. Comcast is without sufficient knowledge or information sufficient to form a belief as to the truth of the allegations regarding Rembrandt's ownership and right to enforce U.S. Patent No. 4,937,819 ("the '819 patent").

27. Comcast admits that the United States Patent and Trademark Office issued the '819 patent on June 26, 1990. Comcast is without sufficient knowledge to form a belief as to the truth of whether the '819 patent was "duly and legally issued" because these terms are not defined.

28. Denied.

29. Denied.

30. Denied.

Except what is specifically admitted here, Comcast denies each and every allegation in the Complaint.

AFFIRMATIVE DEFENSES

FIRST AFFIRMATIVE DEFENSE

(Failure to State a Claim)

Counts I-IV

1. Counts I-IV of the Complaint fail to state a claim upon which relief can be granted.
2. Comcast has not infringed any claim of any of the '627, '631, '858, '819 patents ("Rembrandt's asserted patents").
3. Comcast has not caused, with knowledge, specific intent, or otherwise, equipment suppliers, service providers, and/or others to infringe any claim of any of Rembrandt's asserted patents.
4. Rembrandt has not been damaged in any amount, manner, or at all by reason of any act alleged against Comcast and therefore the relief prayed for cannot be granted.
5. Rembrandt is not entitled to permanent injunctive relief.

SECOND AFFIRMATIVE DEFENSE

(Invalidity)

Counts I-IV

6. On information and belief, Rembrandt's asserted patents are invalid at least for failure to satisfy one or more of the conditions of Title 35 United States Code, including without limitation, Sections 101, 102, 103, and 112 thereof.

THIRD AFFIRMATIVE DEFENSE

(Misuse)

Counts I-IV

7. On information and belief, Rembrandt's asserted patents have been misused by

Rembrandt by the commencement and maintenance of this action, in bad faith, without probable cause in knowing, or when it should have known, that it had no valid claim of patent infringement against Comcast, and for Rembrandt's enforcement of said patents and demands for royalties and other damages with respect to products not covered by its patents.

8. More specifically, and without limiting the generality of the foregoing paragraph, when the '627 Patent issued in 1993, it was assigned to AT&T Bell Laboratories, a subsidiary or affiliate of AT&T Corporation ("AT&T"). Also in 1993, AT&T and several other companies and institutions joined together to form the HDTV Grand Alliance ("Grand Alliance"), whose mission was to develop a standard for the transmission of digital television.

9. The Grand Alliance coordinated with the Advanced Television Systems Committee ("ATSC"), a standards-setting organization, to create a standard for high-definition television broadcasting. The FCC ultimately adopted the major components of the ATSC standard. In adopting the ATSC standard, the FCC expressly premised its order upon, among other things, the Grand Alliance members' agreement to make any of their relevant patents available either free of charge or on a reasonable, nondiscriminatory basis. AT&T, as a member of the Grand Alliance, was bound by this agreement, and expressly committed to make licenses to any of its patents essential to practicing that standard available under reasonable terms and conditions on a non-discriminatory, non-exclusive basis.

10. When Paradyne Corporation ("Paradyne") was spun off from AT&T, it took any rights that it may have had to the '627 Patent subject to AT&T's commitment to license that patent on reasonable and nondiscriminatory terms. When Rembrandt purchased the '627 Patent from Paradyne, it similarly took any rights to that patent subject to the agreement that AT&T had made to license the patent on reasonable terms and on a non-discriminatory basis.

11. Rembrandt has actual knowledge of AT&T's commitment with respect to the '627 Patent. Yet in asserting that Comcast infringes the '627 Patent by its alleged practice of the ATSC standard, Rembrandt has failed to honor AT&T's commitment to license that patent at

reasonable and nondiscriminatory rates; instead, it seeks exorbitant and oppressive royalty rates, and an injunction. Rembrandt is therefore guilty of patent misuse.

FOURTH AFFIRMATIVE DEFENSE

(Laches)

Counts I-IV

12. Rembrandt's claims are barred, in whole or in part, by the doctrine of laches.

13. More specifically, and without limiting the generality of the foregoing paragraph, Rembrandt has accused devices that practice the ATSC standard and/or one or more of the DOCSIS standards of infringing the patents-in-suit.

14. Comcast and/or its predecessors in interest have used products or services that comply with one or more of the DOCSIS standards since no later than May of 1998. Rembrandt knew or reasonably should have known that Comcast and/or its predecessors in interest had used such products or services at that time and since. However, Rembrandt failed to assert its current claims that Comcast infringes the patents-in-suit until September of 2005.

15. Comcast and/or its predecessors in interest have used products or services that comply with the ATSC standard since no later than February of 2001. Rembrandt knew or reasonably should have known that Comcast and/or its predecessors in interest had used such products or services at that time and since. However, Rembrandt failed to assert its current claims that Comcast infringes the patents-in-suit until September of 2005.

16. Rembrandt's delay in filing suit is unreasonable and inexcusable, and has caused Comcast material evidentiary and/or economic prejudice. Rembrandt's claims are accordingly barred by the doctrine of laches.

FIFTH AFFIRMATIVE DEFENSE

(Fraud on the United States Patent and Trademark Office)

Count I

17. Rembrandt's '627 Patent is unenforceable because it was obtained through inequitable conduct.

18. More specifically, and without limiting the generality of the foregoing paragraph, William Betts (a named inventor on the '627 Patent) committed fraud on the U.S. Patent and Trademark Office ("PTO") when prosecuting the '627 Patent. Mr. Betts' fraud on the PTO renders the '627 Patent unenforceable.

19. As described in more detail below, while prosecuting the '627 Patent, Mr. Betts knew of multiple prior art references material to the patentability of the claims in the '627 Patent. Mr. Betts failed to disclose those items of prior art. These failures to disclose violated Mr. Betts' duty of candor to the PTO and constituted fraud on the PTO. Moreover, Comcast is informed and believes that Mr. Betts' failures to disclose were accompanied by intent to deceive. Mr. Betts' violation of his duty of candor as to each individual element of prior art and taken together -- also known as fraud on the patent office or inequitable conduct -- renders the '627 Patent unenforceable.

20. Mr. Betts is a named inventor on United States Patent No. 4,677,626 ("the '626 Patent"), entitled "Self-Synchronizing Interleaver for Trellis Encoder Used in Wireline Modems." That patent was issued on June 30, 1987, and is therefore prior art to the '627 Patent.

21. The '626 Patent constitutes material prior art to the '627 Patent, such that a reasonable patent examiner would have been substantially likely to consider the '626 Patent that Mr. Betts failed to disclose as important in deciding whether to allow the application for the '627 Patent to issue as a patent. Mr. Betts incontestably knew of the '626 Patent and its materiality, as he was a named inventor on that patent. Mr. Betts' failure to disclose the '626 Patent to the PTO violated his duty of candor.

22. United States Patent No. 5,052,000 (“the ’000 Patent”), entitled “Technique for Improving the Operation of Decision Feedback Equalizers in Communications Systems Using Error Correction,” was issued on September 24, 1991 to Wang et al., on an application filed on June 9, 1989. It is therefore prior art to the ’627 Patent.

23. The ’000 Patent constitutes material prior art to the ’627 Patent, such that a reasonable patent examiner would have been substantially likely to consider the ’000 Patent that Mr. Betts failed to disclose as important in deciding whether to allow the application for the ’627 Patent to issue as a patent. On information and belief, Mr. Betts knew of the invention of the ’000 Patent and its materiality, as he was a colleague of Wang’s in the AT&T family of companies, and received a paper co-authored by Wang that described the invention of that patent. Mr. Betts’ failure to disclose the ’000 Patent to the PTO violated his duty of candor.

COUNTERCLAIMS

Defendant and Counterclaimant Comcast asserts the following counterclaims against Rembrandt:

1. Comcast Corp. is a corporation incorporated under the laws of Pennsylvania, having its principal place of business at 1500 Market Street, Philadelphia, Pennsylvania. Comcast Cable is a corporation incorporated under the laws of Delaware having its principal place of business at 1500 Market Street, Philadelphia, Pennsylvania. Comcast of Plano, LP is a limited partnership organized under the laws of Delaware having its principal place of business at 1500 Market Street, Philadelphia, Pennsylvania.

2. Comcast is informed and believes, and therefore alleges, that Rembrandt is a corporation incorporated under the laws of the State of New Jersey, with its principal place of business in Bala Cynwyd, Pennsylvania.

3. In its Counterclaims, Comcast seeks declarations of invalidity and non-infringement of Rembrandt’s asserted patents. As such, jurisdiction is proper pursuant to the

Federal Declaratory Judgment Act, 28 U.S.C. §§ 2201 and 2202, under federal question jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a), and as arising under the Patent Laws of the United States, Title 35, United States Code.

4. This Court has personal jurisdiction over Rembrandt.

5. Venue in this district is proper with regards to this counterclaim under 28 U.S.C. §§ 1391 and 1400.

FIRST COUNTERCLAIM FOR RELIEF

Counterclaim for Declaratory Judgment of Non-Infringement, Invalidity, and Unenforceability of U.S. Patent No. 5,243,627

6. Comcast realleges and incorporates by reference Paragraphs 1 through 5 above.

7. As a result of the charges of infringement against Comcast, an actual controversy exists as to infringement, invalidity, and misuse of U.S. Patent No. 5,243,627.

8. Comcast realleges and incorporates by reference its responses as set forth under the headings “Answer” and “Affirmative Defenses” herein.

9. Comcast has not infringed, and is not now infringing, U.S. Patent No. 5,243,627.

10. Comcast has not caused others to infringe, and is not now causing others to infringe, Rembrandt’s asserted patents.

11. Rembrandt’s asserted patents are invalid and/or void under at least 35 U.S.C. §§ 101, 102, 103, and 112.

12. Rembrandt has committed patent misuse by bringing this action with knowledge that Rembrandt’s asserted patents are invalid and/or not infringed.

13. This counterclaim is exceptional under 35 U.S.C. § 285 and Comcast is entitled to award of its reasonable attorneys’ fees.

SECOND COUNTERCLAIM FOR RELIEF

Counterclaim for Declaratory Judgment of Non-Infringement, Invalidity, and Unenforceability of U.S. Patent No. 5,852,631

14. Comcast realleges and incorporates by reference Paragraphs 1 through 13 above.
15. As a result of the charges of infringement against Comcast, an actual controversy exists as to infringement, invalidity, and misuse of U.S. Patent No. 5,852,631.
16. Comcast realleges and incorporates by reference its responses as set forth under the headings “Answer” and “Affirmative Defenses” herein.
17. Comcast has not infringed, and is not now infringing, U.S. Patent No. 5,852,631.
18. Comcast has not caused others to infringe, and is not now causing others to infringe, Rembrandt’s asserted patents.
19. Rembrandt’s asserted patents are invalid and/or void under at least 35 U.S.C. §§ 101, 102, 103, and 112.
20. Rembrandt has committed patent misuse by bringing this action with knowledge that Rembrandt’s asserted patents are invalid and/or not infringed.
21. This counterclaim is exceptional under 35 U.S.C. § 285 and Comcast is entitled to an award of its reasonable attorneys’ fees.

THIRD COUNTERCLAIM FOR RELIEF

Counterclaim for Declaratory Judgment of Non-Infringement, Invalidity, and Unenforceability of U.S. Patent No. 5,719,858

22. Comcast realleges and incorporates by reference Paragraphs 1 through 21 above.
23. As a result of the charges of infringement against Comcast, an actual controversy exists as to infringement, invalidity, and misuse of U.S. Patent No. 5,719,858.
24. Comcast realleges and incorporates by reference its responses as set forth under the headings “Answer” and “Affirmative Defenses” herein.

25. Comcast has not infringed, and is not now infringing, U.S. Patent No. 5,719,858.

26. Comcast has not caused others to infringe, and is not now causing others to infringe, Rembrandt's asserted patents.

27. Rembrandt's asserted patents are invalid and/or void under at least 35 U.S.C. §§ 101, 102, 103, and 112.

28. Rembrandt has committed patent misuse by bringing this action with knowledge that Rembrandt's asserted patents are invalid and/or not infringed.

29. This counterclaim is exceptional under 35 U.S.C. § 285 and Comcast is entitled to an award of its reasonable attorneys' fees.

FOURTH COUNTERCLAIM FOR RELIEF

Counterclaim for Declaratory Judgment of Non-Infringement, Invalidity, and Unenforceability of U.S. Patent No. 4,937,819

30. Comcast realleges and incorporates by reference Paragraphs 1 through 29 above.

31. As a result of the charges of infringement against Comcast, an actual controversy exists as to infringement, invalidity, and misuse of U.S. Patent No. 4,937,819.

32. Comcast realleges and incorporates by reference its responses as set forth under the headings "Answer" and "Affirmative Defenses" herein.

33. Comcast has not infringed, and is not now infringing, U.S. Patent No. 4,937,819.

34. Comcast has not caused others to infringe, and is not now causing others to infringe, Rembrandt's asserted patents.

35. Rembrandt's asserted patents are invalid and/or void under at least 35 U.S.C. §§ 101, 102, 103, and 112.

36. Rembrandt has committed patent misuse by bringing this action with knowledge that Rembrandt's asserted patents are invalid and/or not infringed.

37. This counterclaim is exceptional under 35 U.S.C. § 285 and Comcast is entitled to an award of its reasonable attorneys' fees.

JURY DEMAND

Pursuant to Fed. R. Civ. P. 38(b), Comcast demands a trial by jury of all issues so triable in this action, including without limitation, those issues raised in the Complaint, Answer, Affirmative Defenses, and Counterclaims.

REQUEST FOR RELIEF

WHEREFORE, Comcast respectfully requests for judgment against Rembrandt as follows:

- A. For dismissal of Rembrandt's Complaint with prejudice and that the relief requested be denied;
- B. For a judgment declaring that no claim of the Rembrandt patent(s) has been infringed willfully, deliberately, or otherwise by Comcast;
- C. For a judgment declaring that each and every claim of the Rembrandt patent(s) is invalid;
- D. For an award of Comcast's reasonable attorneys' fees pursuant to 35 U.S.C. § 285; and
- E. For such other and further relief as the Court may deem jus and fair.

Respectfully submitted,

/s/ Jennifer Haltom Doan
Jennifer Haltom Doan
Texas Bar No. 08809050
John Peyton Perkins, III
Texas Bar No. 24043457
HALTOM & DOAN
6500 N. Summerhill Road, Suite 1A
P. O. Box 6227
Texarkana, TX 75505-6227
Telephone: 903-255-1000
Facsimile: 903-255-0800

Brian Ferrall
Leo Lam
Matthew M. Werdegarr
Eric H. MacMichael
Keker & Van Nest, LLP
710 Sansome Street
San Francisco, CA 94111-1704
Telephone: 415-676-2235
Facsimile: 415-397-7188

**ATTORNEYS FOR DEFENDANTS
COMCAST CORPORATION,
COMCAST CABLE
COMMUNICATIONS, LLC, and
COMCAST OF PLANO, LP**

CERTIFICATE OF SERVICE

The undersigned certifies that the foregoing document was filed electronically in compliance with Local Rule CV-5(a). As such, this answer was served on all counsel who are deemed to have consented to electronic service. All other counsel of record not deemed to have consented to electronic service were served with a true and correct copy of the foregoing by certified mail, return receipt requested, on this 27th day of November, 2006.

/s/ Jennifer Haltom Doan
Jennifer Haltom Doan

**UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION, COMCAST
CABLE COMMUNICATIONS, LLC, and
COMCAST OF PLANO, LP

§
§
§
§
§
§
§

Civil Action No. 2:05-cv-443 [TJW]
JURY DEMANDED

**TIME WARNER CABLE INC.'S UNOPPOSED
MOTION FOR ENTRY OF AMENDED PROTECTIVE ORDER**

TO THE HONORABLE JUDGE OF SAID COURT:

COMES NOW Time Warner Cable Inc. ("TWC") and presents to the Court its Unopposed Motion for Entry of Amended Protective Order, and for said Motion would respectfully show the Court as follows:

I.

On June 15, 2006 the Court entered its Protective Order in this case. TWC intervened in this case on August 30, 2006, solely for the purpose of presenting a Motion to Disqualify Fish & Richardson, P.C. as counsel of record for Rembrandt Technologies, LP ("Rembrandt"). TWC requests that the Protective Order be amended to define the obligations of outside counsel for TWC and other designated individuals in the event that those individuals receive confidential information in this case. In order to preserve the confidential nature of the Party's information TWC requests entry of the proposed Amended Protective Order, which is attached hereto as Exhibit "A."

II.

WHEREFORE, PREMISES CONSIDERED, Time Warner Cable Inc. respectfully requests that this Motion be granted and the proposed Amended Protective Order be entered.

Dated: November 29, 2006

Respectfully submitted,

Of Counsel:

David S. Benyacar
KAYE SCHOLER LLP
425 Park Avenue
New York, New York 10022
Telephone: (212) 836-8000
Facsimile: (212) 836-8689

/s/ Diane V. DeVasto
Michael E. Jones
Texas State Bar No. 10929400
mikejones@potterminton.com
Diane V. DeVasto
Texas State Bar No. 05784100
dianedevasto@potterminton.com
POTTER MINTON, P.C.
110 North College
500 Plaza Tower
Tyler, Texas 75702
Telephone: (903) 597-8311
Facsimile: (903) 593-0846

**ATTORNEYS FOR
TIME WARNER CABLE INC.**

CERTIFICATE OF SERVICE

The undersigned hereby certifies that all counsel of record who are deemed to have consented to electronic service are being served with a copy of this document via the Court's CM/ECF system per Local Rule CV-5(a)(3) on November 29, 2006. Any other counsel of record will be served by first class on this same date.

/s/ Diane V. DeVasto

CERTIFICATE OF CONFERENCE

Undersigned Counsel for Time Warner Cable Inc. hereby certifies that counsel for Rembrandt Technologies, LP, the Comcast entities, and Fish & Richardson, P.C. have indicated that they do not oppose this Motion.

/s/ Diane V. DeVasto

**UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

REMBRANDT TECHNOLOGIES, LP	§	
	§	
v.	§	Civil Action No. 2:05-cv-443 [TJW]
	§	JURY DEMANDED
COMCAST CORPORATION, COMCAST	§	
CABLE COMMUNICATIONS, LLC, and	§	
COMCAST OF PLANO, LP	§	

AMENDED PROTECTIVE ORDER

WHEREAS, Plaintiff Rembrandt Technologies, LP (“Rembrandt”), Defendant Comcast Corporation (“Comcast”), and Intervenor Time Warner Cable Inc. (“TWC”) through counsel, stipulate to entry of this Protective Order (“Order”) pursuant to Fed. R. Civ. P. 26(c) to prevent unnecessary disclosure or dissemination of confidential information; and

WHEREAS, the parties and intervenor recognize that confidential information is being produced for use in this civil action;

IT IS HEREBY ORDERED that the following provisions of this Order shall govern the treatment of confidential information produced by a party (“Producing Party”) to any other party (“Receiving Party”) in the course of this civil action:

1. The term “Confidential Information” as used in this Order includes all information and tangible things that constitute or disclose trade secrets or other confidential or proprietary information of one of the parties. Confidential Information may be contained in discovery information or materials produced or obtained in this action by or through any means and by or through any person or entity. The Confidential Information contained therein and all copies, recordings, abstracts, excerpts, analyses or other writings that contain, reveal or otherwise disclose such Confidential Information shall also be deemed Confidential Information.

2. Confidential Information shall be disclosed, disseminated and used by the Receiving Party only for purposes of litigation between the parties to this action. Except with the prior written consent of the Producing Party or upon prior order of this Court, Confidential Information shall not be disclosed except in accordance with the terms, conditions, and restrictions of this Order.

3. Produced documents, interrogatory responses, responses to requests for admission and other documents containing “Confidential Information” shall be marked by conspicuously affixing a legend, which includes the words “CONFIDENTIAL,” or “HIGHLY CONFIDENTIAL—ATTORNEYS’ EYES ONLY”, as appropriate, on each page containing Confidential Information at the time such documents are produced or such information is disclosed (or on the cover or container of computer storage media, such as discs or tapes). The parties may designate material other than the produced documents as containing Confidential Information in the following manner:

(a) Testimony or information disclosed at a deposition that contains Confidential Information or Highly Confidential Information may be designated by indicating on the record at the deposition the portions of the testimony which contain such information that is to be made subject to the provisions of this Order. Alternatively, a Producing Party may designate testimony or information disclosed at a deposition, including exhibits, that contains Confidential Information or Highly Confidential Information by notifying all parties in writing, within fifteen (15) days after the Producing Party’s receipt of the transcript, of the specific pages and lines of the transcript that contain such information. Whether or not designation is made at the time of a deposition, accessibility to each transcript (and the information contained therein) of any deposition in its entirety shall be limited to outside counsel of record and designated in-

house counsel only, from the taking of the deposition until fifteen (15) days after actual receipt of the transcript by the Producing Party, or until receipt of the notice referred to in this paragraph, whichever occurs sooner. At the expiration of the said fifteen (15) day period, unless notice hereunder to the contrary is given at the time of the deposition or prior to the expiration of said period, the entire transcript shall be deemed non-confidential.

(b) Confidential Information or Highly Confidential Information contained in any affidavits, briefs, memoranda or other papers filed with the Court in this action may be designated as Confidential Information or Highly Confidential Information by indicating on the face of such documents that one or more parties considers them to contain such information.

4. The parties may designate as HIGHLY CONFIDENTIAL—ATTORNEYS’ EYES ONLY any materials that qualify for protection under the standards developed under Fed. R. Civ. P. 26(c), but not including those materials which qualify for the designation “CONFIDENTIAL” under paragraph 5. Subject to the provisions of paragraphs 6 and 7 herein, material designated as HIGHLY CONFIDENTIAL—ATTORNEYS’ EYES ONLY, and any summary, description or report of the information contained in such materials, may be disclosed only to the following persons:

- (a) the Court, persons employed by the Court, and stenographers transcribing the testimony or argument at a hearing, trial or deposition in this action or any appeal therefrom;
- (b) technical and damages consultants and experts who are not current employees of any party in this matter and who have been retained by counsel to provide assistance in this action, with disclosure only to the extent necessary to perform such work;
- (c) graphics, translation, design and/or trial consulting services, including mock jurors, retained by a party;

(d) photocopy, document imaging and database services and consultants retained by counsel to set up, maintain and/or operate computer systems, litigation databases or to convert data for inclusion in such databases;

(e) John Meli, Executive Vice President and General Counsel of Rembrandt, and one in-house counsel employed by Comcast (following identification and approval by Rembrandt, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting each of those two individuals;

(f) John Steele of Fish & Richardson, P.C. and one additional Fish & Richardson, P.C. attorney (following identification and approval by Time Warner Cable Inc. and Comcast, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting them;

(g) with respect to the pleadings and papers, including any declarations or exhibits attached thereto, related to Time Warner Cable's Motion to Intervene and Motion to Disqualify: Andrew T. Block, Vice President and Chief Counsel of Intellectual Property at Time Warner Cable Inc. and one additional in-house counsel employed by Time Warner Cable Inc. (following identification and approval by Rembrandt and Comcast, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting them; John Meli, Executive Vice President and General Counsel for Rembrandt, and Barry Ungar, in-house counsel for Rembrandt, and two (2) paralegals and/or clerical employees assisting them; and Michael Aronoff, Senior Counsel for Comcast, and Lee Zieroth, Vice President and Deputy General Counsel for Comcast, and two (2) paralegals and/or clerical employees assisting them; and

(h) the parties' outside counsel of record in this action as specifically set forth below and any other counsel for a party that appears in this action, and their paralegal assistants, law clerks, stenographic and clerical employees who are assisting in the prosecution, defense and/or appeal of this action. Any individual outside counsel of record who receives information designated HIGHLY CONFIDENTIAL—ATTORNEYS' EYES ONLY may not participate in patent prosecution for the Receiving Party, and the individual outside counsel who receives any such information may not discuss the information with anyone involved in patent prosecution for the Receiving Party. Outside counsel of record for the parties are as follows:

For Rembrandt:

Fish & Richardson P.C.
225 Franklin Street
Boston, MA 02110

Ireland, Carroll & Kelley, P.C.
6101 5. Broadway, Suite 500
Tyler, Texas 75703

Jones & Jones, Inc., P.C
201 West Houston Street, Drawer 1249
Marshall, Texas 75671-1249

Brown McCarroll L.L.P.
1127 Tridson Road, Suite 220
P.O. Box 3999
Longview, Texas 75601-5157

Parker & Clayton
100 E. Ferguson, Suite 1114
Tyler, Texas 75702

For Comcast:

Keker & Van Nest, LLP
710 Sansome Street
San Francisco, CA 94111-1704

Haltom & Doan, LLP

6500 N. Summerhill Road, Suite IA
P.O. BOX 6227
Texarkana, TX 75505-6227

For Time Warner Cable Inc.:

Potter Minton
110 N. College St., Ste. 500
Tyler, TX 75702

Kaye Scholer LLP
425 Park Avenue
New York, NY 10022

5. The parties may designate as CONFIDENTIAL any materials of a financial or accounting nature that qualify for protection under the standards developed under Fed. R. Civ. P. 26(c). Subject to the provisions of paragraphs 6 and 7 herein, material designated as CONFIDENTIAL, and any summary, description or report of the information contained in such materials, may be disclosed only to the following persons:

- (a) the Court, persons employed by the Court, and stenographers transcribing the testimony or argument at a hearing, trial or deposition in this action or any appeal therefrom;
- (b) technical and damages consultants and experts who are not current employees of any party in this matter and who have been retained by counsel to provide assistance in this action, with disclosure only to the extent necessary to perform such work;
- (c) graphics, translation, design and/or trial consulting services, including mock jurors, retained by a party;
- (d) photocopy, document imaging and database services and consultants retained by counsel to set up, maintain and/or operate computer systems, litigation databases or to convert data for inclusion in such databases;

(e) John Meli, Executive Vice President and General Counsel of Rembrandt, and one in-house counsel employed by Comcast (following identification and approval by Rembrandt, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting each of those two individuals;

(f) John Steele of Fish & Richardson, P.C. and one additional Fish & Richardson, P.C. attorney (following identification and approval by Time Warner Cable Inc. and Comcast, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting them;

(g) with respect to the pleadings and papers, including any declarations or exhibits attached thereto, related to Time Warner Cable's Motion to Intervene and Motion to Disqualify: Andrew T. Block, Vice President and Chief Counsel of Intellectual Property at Time Warner Cable Inc. and one additional in-house counsel employed by Time Warner Cable Inc. (following identification and approval by Rembrandt and Comcast, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting them; John Meli, Executive Vice President and General Counsel for Rembrandt, and Barry Ungar, in-house counsel for Rembrandt, and two (2) paralegals and/or clerical employees assisting them; and Michael Aronoff, Senior Counsel for Comcast, and Lee Zieroth, Vice President and Deputy General Counsel for Comcast, and two (2) paralegals and/or clerical employees assisting them; and

(h) the parties' outside counsel of record in this action as specifically set forth in paragraph 4(h) and any other counsel for a party that appears in this action, and their paralegal assistants, law clerks, stenographic and clerical employees who are assisting in the prosecution, defense and/or appeal of this action.

6. (a) A party may exclude from a deposition any person who is not entitled to view Confidential Information or Highly Confidential Information when such information is the subject of examination.

(b) No Confidential Information or Highly Confidential Information shall be revealed or disclosed, in whole or in part, directly or indirectly, to any individual described in subparagraphs 4(b)-(g) and 5(b)-(g) until that individual has been given a copy of this Order and has duly completed and signed an undertaking in the form attached hereto as Exhibit A, the original of which shall be retained, until the conclusion of this action including all appeals, by counsel for each party who intends to or does disclose to such individual any Confidential Information at Highly Confidential Information.

(c) Before individuals under subparagraphs 4(b) and 5(b) may have access to Confidential Information or Highly Confidential Information, the Receiving Party must submit to the Producing Party the individual's signed undertaking as well as the individual's curriculum vitae setting forth his or her name, address, qualifications and relevant work experience, including, but not limited to, the identity of any company in the telecommunications industry for whom said individual has consulted or worked during the last five (5) years. If the Producing Party does not object in writing, within five (5) business days from receipt of the undertaking, Confidential Information or Highly Confidential Information may then be disclosed to the retained consultant or former employee. If timely objection is made, the parties shall attempt in good faith to resolve the disclosure issue. If the issue cannot be resolved, the Producing Party has fifteen (15) days from receipt of the undertaking to bring a motion to preclude the retained consultant or former employee from viewing the Producing Party's Confidential Information or Highly Confidential Information. If the Producing Party does not bring such a timely motion,

Confidential Information or Highly Confidential Information may be disclosed to the retained consultant or former employee.

(d) Pursuant to subparagraph 6(c), the disclosure of the identity of a consulting expert will not be a waiver of any privilege or right to withhold from production that applies to communications or work product. Furthermore, the parties agree that by stipulating to the entry of this Protective Order, the parties do not intend to modify in any way the normal discovery rules applicable to consulting experts, or other agreements reached between the parties regarding such discovery.

7. In addition to the terms set forth in paragraphs 4 through 6 herein governing the disclosure of Confidential Information or Highly Confidential Information, information or materials that contain, embody, or otherwise reflect a party's source code shall be provided the following further protections:

(a) Any and all such source code, except for hard (non-electronic) copies, shall be stored and viewed only at the offices of one (1) agreed-upon source code custodian ("Source Code Custodian") located in one of the following locations:

Wilmington, Delaware; Boston, Massachusetts; or Austin, Texas.

(b) Subject to subparagraphs (c) and (d), any source code produced in electronic form shall be stored and viewed only at the offices of the Source Code Custodian and shall be maintained in a secured, locked area. No electronic copies of source code shall be made. Any such source code shall only be viewed or analyzed on a stand-alone computer (a computer that is not connected to any internal or external computer or computer network) located within the above-described locations. The Source Code Custodian shall maintain a Source Code Access Log identifying for each and every time any source code is viewed, accessed or analyzed: (1) the

name of each person who accessed the code; (2) the date and time of access; (3) the length of time of access; and (4) whether any hard (non-electronic) copies of any portion of the code were copied and the portion of the code copied. The Receiving Party reviewing source code shall be allowed to make hard (non-electronic) copies of material that they, in good faith, consider relevant. The parties shall negotiate reasonable limitations on the amount of source code that is released by Producing Party at any given time.

(c) Any hard (non-electronic) copies of source code shall be stored and viewed only within the United States at:

(i) a secured, locked area in one of the offices of the Source Code Custodian, each such location within the United States, provided the hard (non-electronic) copies are marked with the designation “HIGHLY CONFIDENTIAL—ATTORNEYS’ EYES ONLY”;

(ii) the Court;

(iii) the site where any deposition relating to the source code is taken;

(iv) any intermediate location reasonably necessary to transport the information (e.g., a hotel prior to the deposition).

(d) For each and every hard (non-electronic) copy of any source code, or any portion of any source code, the Source Code Custodian shall maintain a log detailing the location of the copy. Excessive reproduction of source code should be avoided

(e) Prior to the Receiving Party taking possession of a hard (non-electronic) copy of source code as provided for under this paragraph, the Receiving Party shall inform the Producing Party as to specifically what portions of source code it plans to take into its possession. The Producing Party shall then have twenty-four (24) hours if informed on a weekday, or seventy-two (72) hours if informed on a weekend in which to object in writing to

the Receiving Party as to the extent or relevance of the source code the reviewing party seeks to possess. If objection is made, the parties shall meet and confer in good faith within three (3) business days and attempt to resolve the objection. If the objection is not resolved, the Producing Party shall have five (5) business days after the conference to file a motion with the Court for relief from production of the subject portions of source code. The subject portions of source code shall be retained by the Producing Party, pending the court's resolution of the motion.

(f) To the extent any source code becomes an exhibit to a deposition, one copy of the exhibit may be maintained at the U.S. office of outside counsel of record for each party in a secure, locked area. Counsel shall not designate source code as an exhibit solely for authentication purposes and shall only designate as an exhibit that portion of source code reasonably necessary for questioning.

8. Designation of Confidential Information or Highly Confidential Information as "HIGHLY CONFIDENTIAL—ATTORNEYS' EYES ONLY" or "CONFIDENTIAL" shall constitute a representation that such information has been reviewed by an attorney for the Producing Party and that there is a valid basis for such designation. Subject to the conditions set forth in Paragraph 7, Confidential Information or Highly Confidential Information shall be maintained by the Receiving Party under the overall supervision of outside counsel. The attorneys of record for the parties shall exercise best efforts to ensure that the information and documents governed by this Protective Order are (i) used only for the purposes set forth herein, and (ii) disclosed only to authorized persons. Moreover, any person in possession of Confidential Information or Highly Confidential Information shall exercise reasonably appropriate care with regard to the storage, custody or use of such Confidential Information or

Highly Confidential Information in order to ensure that the confidential or restricted nature of the same is maintained.

9. It is the intention of this Protective Order that the following categories of information shall not be and should therefore not be designated as Confidential Information or Highly Confidential Information: (a) any information that at the time of its disclosure in this action is part of the public domain by reason of publication or otherwise; (b) any information that after its disclosure in this action has become part of the public domain by reason of publication or otherwise through no act, omission or fault of the Receiving Party; (c) any information that at the time of its disclosure in this action is rightfully in the possession of the Receiving Party, its trial counsel or any expert retained by or for the Receiving Party under no obligations of confidence to any third party with respect to that information; or (d) any information that after its disclosure in this action is rightfully received by the Receiving Party, its trial counsel or any expert retained by or for the Receiving Party under no obligations of confidence or otherwise from any third party having the right to make such disclosure. During the pendency of this action, any disputes as to whether information is confidential under the terms of this Order shall be resolved according to the procedure set forth in paragraph 10 hereof.

10. If a party disagrees with any Confidential Information or Highly Confidential Information designation, such party shall first make its objection known to the Producing Party and request a change of designation. The parties shall first try to dispose of such dispute in good faith on an informal basis. If the dispute cannot be resolved, the party challenging the designation may request appropriate relief from the Court no sooner than five (5) days following the service of a written notice of disagreement. The burden of proving that information has been properly designated as Confidential Information or Highly Confidential Information is on the

party making such designation. Until a determination by the Court, the information in issue shall be treated as Confidential Information or Highly Confidential Information and subject to the terms of this Order. Any failure to object to any material being designated as Confidential Information or Highly Confidential Information shall not be construed as an admission by any non-designating party that the material constitutes or contains a trade secret or other confidential information.

11. During the course of preparing for a deposition or testimony, unless otherwise entitled to access under this Protective Order, a fact deponent/witness may be shown Confidential Information or Highly Confidential Information from another party's documents strictly limited to those documents which on their face reveal that they were authored or received by the deponent/witness in the normal course of business and outside the context of this litigation. This shall not preclude a Producing Party from showing documents that it has produced to its own witnesses and deponents, regardless whether the Producing Party has designated the document(s) it produced as Confidential, and regardless whether such person was the author or a recipient of the document.

12. At the deposition of a third party or former employee of a Producing Party, such third party or former employee of a Producing Party may be shown documents designated as Confidential only if the document was authored by or received by that third party or former employee.

13. Any person receiving Confidential Information or Highly Confidential Information shall not disclose such information to any person who is not entitled to receive such information under this Order. If Confidential Information or Highly Confidential Information is disclosed to any person not entitled to receive disclosure of such information under this Order,

the person responsible for the disclosure will inform counsel for the Producing Party and, without prejudice to other rights and remedies of any party, make a reasonable good faith effort to retrieve such material and to prevent further disclosure by the person who received such information.

14. Written material constituting or revealing Confidential Information or Highly Confidential Information, when filed with the Court in this action for any reason, shall be filed in sealed envelopes or other appropriate sealed containers on which shall be endorsed the title of this action, an indication of the nature of the contents of such sealed envelope or other container, a designation in the form set forth in paragraphs 4 or 5 hereof, and a statement substantially in the following form:

HIGHLY CONFIDENTIAL—ATTORNEYS' EYES ONLY
FILED UNDER SEAL PURSUANT TO COURT ORDER
Civil Action No. 2:05cv443-TJW

15. The Clerk of the Court is directed to place and maintain under seal in accordance with this Order any such pleading or other document filed with or delivered to this Court pursuant to Paragraph 14 or any other provision thereof.

16. Nothing herein shall prevent disclosure beyond the terms of this Order if the party producing Confidential Information or Highly Confidential Information consents in writing to such disclosure, or if the Court, after notice to all affected parties, orders or permits such disclosure.

17. The inadvertent production in discovery of any privileged or otherwise protected or exempted information, as well as the inadvertent production in discovery of information without an appropriate designation of confidentiality, shall not be deemed a waiver or impairment of any claim or privilege or protection including but not limited to the attorney-

client privilege, the protection afforded to work-product materials or the subject matter thereof, or the confidential nature of any such information, provided that the Producing Party shall promptly notify the Receiving Party in writing when inadvertent production is discovered. Upon receiving written notice from the Producing Party that privileged information or work-product material has been inadvertently produced, all such information, and all copies thereof, shall be returned to counsel for the Producing Party and the Receiving Party shall not use such information for any purpose until the Order of the Court.

18. Any violation of the terms of this Protective Order shall be punishable by money damages, interim or final injunctive or other equitable relief, sanctions, contempt of court citation, or such other or additional relief as deemed appropriate by the Court.

19. Until such time as this Protective Order has been entered by the Court, the parties agree that upon execution by the parties, it will be treated as though it had been "So Ordered."

20. Third parties who produce information in this action may avail themselves of the provisions of this Protective Order, and discovery materials produced by third parties shall then be treated by the parties in conformance with this Protective Order.

21. By entering this Order and limiting the disclosure of information in this case, the Court does not intend to preclude another court from finding that such information may be relevant and subject to disclosure in another case. Any person or party subject to this order that may be subject to a motion to disclose another party's information designated Confidential or pursuant to this order shall promptly notify that party of the motion so that it may have an opportunity to appear and be heard on whether that information should be disclosed.

22. In the event that any of the parties (a) is subpoenaed in another action, (b) is served with a demand in another action to which it is a party, or (c) is served with any other legal

process by a person not a party to this litigation, and is requested to produce or otherwise disclose discovery material that is designated as Confidential by another party, the party subpoenaed or served in accordance with this paragraph shall object to production of the Confidential material and shall give prompt written notice to the Producing Party. Should the person seeking access to the Confidential material take action against the party covered by this Order to enforce such a subpoena, demand or other legal process, it shall respond by setting forth the existence of this Order. Nothing in this Order shall be construed as requiring production of Confidential material covered by this Order.

23. (a) Within sixty (60) days after filing of the final judgment in this action, or, if such judgment is appealed from entry of a mandate affirming such final judgment, all Confidential Information or Highly Confidential Information shall be destroyed by all Receiving Parties or shall be returned to the Producing Party at the written election of the Producing Party which election shall be made within twenty days of the filing of the aforementioned final judgment or mandate. If any Receiving Party destroys any such Confidential Information or Highly Confidential Information, that party shall inform the Producing Party in writing.

(b) Notwithstanding the foregoing, one designated outside counsel of record for each party may maintain in its files one copy of each affidavit, affirmation, certification, declaration, brief record on appeal, notice of motion, deposition transcript, exhibit to a deposition or affidavit (or the like), exhibit at a hearing or trial, pleading, discovery request, stipulation, correspondence between counsel for the parties, written response to a discovery request or any other document filed with the Court and the court transcript, consisting of or containing Confidential Information or Highly Confidential Information. The Receiving Party shall be entitled to retain one copy, and outside counsel of record for each party shall be entitled to retain copies of any expert report

containing any Confidential Information or Highly Confidential information of the Producing Party, which is not in the public docket file. All such material shall remain subject to the terms of this Order.

24. This Order may be amended with leave of the Court by the agreement of counsel for the parties in the form of a stipulation that shall be filed in this action.

25. This Order shall remain in full force and effect until modified, superseded, or terminated on the record by agreement of the parties or by an Order of the Court.

26. At the conclusion of the present action, the Court shall retain jurisdiction to enforce the terms of this Order.

EXHIBIT A

**UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

REMBRANDT TECHNOLOGIES, LP	§	
	§	
v.	§	Civil Action No. 2:05-cv-443 [TJW]
	§	JURY DEMANDED
COMCAST CORPORATION, COMCAST	§	
CABLE COMMUNICATIONS, LLC, and	§	
COMCAST OF PLANO, LP	§	

I, _____ hereby declare that:

1. I have carefully read and understand the foregoing Protective Order (the “Order”) of the United States District Court for the Eastern District of Texas, in the above-captioned matter.

2. I agree that I will be bound by and will comply with all of the provisions of this Order and I will make no disclosures of Confidential Information or Highly Confidential Information to any person who is not permitted to have access to such Confidential Information or Highly Confidential Information by this Order, as applicable.

3. Upon final determination of this action, I will destroy all Confidential Information or Highly Confidential Information received by me within sixty (60) days after filing of the final order or mandate as described in paragraph 23(a), or I will return such Confidential Information or Highly Confidential Information within sixty (60) days to the Producing Party. If I destroy such Confidential Information or Highly Confidential Information, I agree to send a letter to the Producing Party confirming the same.

4. I understand that a violation of this undertaking is punishable as a contempt of court and hereby submit to the jurisdiction of this Court for the purpose of enforcement of this Order.

5. I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on: _____

[signature]

[print or type name]

Title:

Business Affiliation:

Address:

Phone:

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION, COMCAST
CABLE COMMUNICATIONS, LLC, and
COMCAST OF PLANO, LP

§
§
§
§
§
§
§

Civil Action No. 2:05-cv-443 [TJW]
JURY DEMANDED

**ORDER GRANTING TIME WARNER CABLE INC.'S
MOTION FOR ENTRY OF AMENDED PROTECTIVE ORDER**

Before the Court is Time Warner Cable Inc.'s Motion for Entry of Amended Protective Order. Having considered the Motion, the Court finds it is good and should be GRANTED.

IT IS THEREFORE ORDERED, that the Amended Protective Order be entered and that Time Warner Cable Inc. is bound by the terms and conditions of the Amended Protective Order with respect to any and all confidential information it may receive.

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

**REMBRANDT TECHNOLOGIES, LP'S UNOPPOSED MOTION FOR LEAVE TO
AMEND ITS P.R. 4-3**

Plaintiff Rembrandt Technologies, LP moves this Court for leave to amend the Joint Claim Construction and Prehearing Statement pursuant to P.R. 4-3.

On November 14, 2006, the parties filed their Joint Claim Construction and Prehearing Statement pursuant to P.R. 4-3.

Rembrandt now seeks leave to file the amended claims construction terms as follows:

*858 Patent Claim Terms	Plaintiff Rembrandt's Previous Proposed Construction	Plaintiff Rembrandt's Amended Proposed Construction
time-division multiplexed bus (claims 1, 7, 9, 11, 15, 20)	a bus having a bandwidth partitioned into regular time slots and bit-time slots, that is shared by two or more sources of data by limiting each source's transmission opportunities to discrete intervals of time	a bus having a bandwidth partitioned into regular time slots, that is shared by two or more sources of data by limiting each source's transmission opportunities to discrete intervals of time
distributed packet manager (claims 1, 7)	a device, process or algorithm that is located within each packet data source, that controls how the packet data source accesses a portion of the bandwidth assigned to packet data, and that accepts an entire packet stream from a network access module to obtain data addressed to the packet data source	a device, process or algorithm that is located within each packet data source, that controls how the packet data source accesses a portion of the bandwidth assigned to packet data

Rembrandt has conferred with counsel for Defendants regarding this matter and informed Defendants regarding the nature of the amendments to the claim construction terms, which is attached hereto as Exhibit A. Defendants have stated that they do not oppose Rembrandt amending its claim construction terms.

Rembrandt seeks this amendment not for delay, but for good cause and so that justice may be served.

Dated: November 29, 2006

FISH & RICHARDSON P.C.

By: /s/ Thomas A. Brown by permission Andrew W. Spangler

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CERTIFICATE OF CONFERENCE

I hereby certify that on November 28, 2006, counsel for Plaintiff, Thomas A. Brown, met and conferred with opposing counsel regarding the instant Motion. Defendants do not oppose the relief sought in this Motion.

/s/ Andrew W. Spangler
Andrew W. Spangler

CERTIFICATE OF SERVICE

I hereby certify that counsel of record who are deemed to have consented to electronic service are being served this 29th day of November, 2006, with a copy of this document via the Court's CM/ECF system per Local Rule CV-5(a)(3). Any other counsel of record will be served by electronic mail, facsimile transmission and/or first class mail on this same date.

/s/ Andrew W. Spangler

Andrew W. Spangler

EXHIBIT A

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

**FIRST AMENDED JOINT CLAIM CONSTRUCTION AND PREHEARING
STATEMENT**

Pursuant to Eastern District of Texas Patent Rule 4-3, Plaintiff Rembrandt Technologies LP (“Rembrandt”), and Defendants Comcast Corporation, Comcast Cable Communications, LLC, and Comcast of Plano, LP (collectively “Comcast”) hereby provide their Joint Claim Construction and Prehearing Statement.

I. AGREED CLAIM CONSTRUCTIONS

The parties have agreed that certain claim terms, phrases, or clauses that were the subject of the parties’ Patent Rule 4-2 Exchange do not presently require construction by the Court, and have removed those claim terms, phrases, or clauses from the charts attached to this pleading.

The parties have also agreed as to the function of certain of the means-plus-function terms in the patents-in-suit. Because the corresponding structure remains in dispute, these terms are listed in exhibit A, attached.

II. DISPUTED CLAIM CONSTRUCTIONS

The parties have set forth their proposed constructions, including the intrinsic and extrinsic evidence relied upon in support thereof, in Exhibit A, attached. The parties

reserve the right to rely on any evidence cited by either party. The parties further reserve the right to offer rebuttal expert testimony on any claim term for which the other party offers expert testimony.

III. ANTICIPATED LENGTH OF CLAIM CONSTRUCTION HEARING

The parties believe that it would be appropriate for the Court to allocate four hours to the claim construction hearing, with two hours allocated to each side, including reserved rebuttal time.

IV. CLAIM CONSTRUCTION WITNESSES

The parties do not anticipate calling live witnesses at the claim construction hearing except as the Court may request. If so requested, Rembrandt would present the testimony of Dr. V. Thomas Rhyne and Dr. Stephen Wicker. Comcast would present the testimony of Dr. Curtis A. Siller, Jr., and Dr. Harry Bims.

V. CLAIM CONSTRUCTION PREHEARING CONFERENCE

The parties do not believe a claim construction prehearing conference is needed, except at the request of the Court.

Dated: November 14, 2006

Respectfully submitted,

By: _____

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CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing was served by electronic filing to all counsel of record on this 14th day of November, 2006.

Thomas A. Brown

EXHIBIT A: DISPUTED CLAIM TERMS

United States Patent No. 5,243,627

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
trellis encoded channel symbol (claims 9, 19)	<p><u>Proposed construction</u></p> <p>A set of one or more trellis encoded signal points that corresponds to a group of bits that is treated as a unit by an encoding system</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract.</p> <p>Figures 1, 2, 3, 4, 5, 6, 7.</p> <p>Column 1, line 34 – column 2, line 50.</p> <p>Column 2, line 61 – column 3, line 3.</p> <p>Column 3, line 19 – column 4, line 24.</p> <p>Column 5, lines 1 – 41.</p> <p>Column 6, line 46 – column 9, line 51.</p> <p>Claims 1, 3, 11, 13, 21 and 23.</p> <p><u>Extrinsic Evidence</u></p> <p>U.S. Patent No. 5,559,561 (REM0086656-REM0086673)</p> <p>U.S. Patent No. 5,706,312 (REM0086674-REM0086687)</p> <p>U.S. Patent No. 5,512,957 (REM0086636-REM0086655)</p> <p>802.14 PHY Proposal, Thomas Kolze (Cable TV Protocol Working Group), October 1995 (COMREM00669632-</p>	<p>The output of a mapper that is generated from the output of a single state transition of a trellis encoder.</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract</p> <p>Col 1 Lns. 38-44; 48-58; 59</p> <p>Col 2 Ln 2; 5-13; 14-18; 21-28; 31-50; 53 – Col. 4 Ln. 3;</p> <p>Col 4 Lns 4-11; 12-24</p> <p>Col 6 Lns 3-23; 36-39; Ln 55 – Col 7 Ln 6</p> <p>Col 7 Lns 9-18; 25-32; 33-54; Ln 55 – Col 8 Ln 9</p> <p>Col 8 Lns 14-35; 38-56; 58 – Col 9 Ln 13</p> <p>Col 9 Lns 14-28; 14-28; 36-44</p> <p>Figures 1-7</p> <p>U.S. Patents Nos. 5,029,185; 3,988,677; 4,677,624; 4,677,625.</p> <p>Prosecution History: December 21, 1992 <i>Amendment</i>, at pgs. 2-6; <i>Notice of Allowability</i>.</p> <p><u>Extrinsic Evidence</u></p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONIC TERMS 1072 (6th ed. 1996) (“Symbol”) (5th definition).</p> <p>JERRY MARTIN ROSENBERG, DICTIONARY OF COMPUTERS, DATA PROCESSING, AND TELECOMMUNICATIONS 518 (1984). (“Symbol”) (3rd definition).</p> <p>JERRY MARTIN ROSENBERG, DICTIONARY OF COMPUTERS,</p>

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>COMREM00669645).</p> <p>Dolinar and Belongie. Enhanced Decoding for the Galileo S-band Mission, August 1993. (REM0086691-REM0086706)</p> <p>Blue Book, Issue-3, Telemetry Channel Coding. Consultative Committee for Space Data Systems, May 1992. (REM0086940-0086981)</p> <p>Technical Report Number 59, Signal Carrier Rate Adaptive Digital Subscriber Line, September 1999. (REM0086707-REM0086896)</p> <p>Data Over Cable Systems Radio Frequency Interface Specification 1.1, Engineering Committee, 2002 (COMREM00845847-COMREM0084624)</p> <p>Data Over Cable Service Interface Specifications 2.0, Radio Frequency Interface Specification, 2003 (REM0065021-REM0065532)</p>	<p>DATA PROCESSING, AND TELECOMMUNICATIONS 479 (1984) ("Signal element") (3rd definition).</p> <p>EZIO BIGLIERI, ET AL., INTRODUCTION TO TRELLIS-CODED MODULATION WITH APPLICATIONS 72-73 (1991).</p> <p>RICHARD D. GITLIN, ET AL., DATA COMMUNICATION PRINCIPLES 355-356 (1992).</p> <p>U.S. Patent No. 4,945,549 at Fig. 1; Col. 4 Lns. 4-31 (filed Sep. 15, 1988).</p> <p>U.S. Patent No. 4,922,507, at Col. 4, Lns. 37-56 (filed Dec. 1, 1987).</p> <p>U.S. Patent No. 5,023,889, at Col. 3, Ln. 38 - Col. 4, Ln. 28 (filed May 31, 1988).</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand this claim term to mean.</p> <p>U.S. Patents Nos. 5,029,185; 3,988,677; 4,677,624; 4,677,625.</p> <p>Prosecution History: December 21, 1992 <i>Amendment</i>, at pgs. 2-6; <i>Notice of Allowability</i>.</p> <p>Wang, et al., U.S. Patent No. 5,052,000.</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract</p> <p>Col 1 Lns. 38-44; 48-58; 59</p> <p>Col 2 Ln 2; 5-13; 14-18; 21-28; 31-50; 53 - Col. 4 Ln. 3;</p> <p>Col 4 Lns 4-11; 12-24</p> <p>Col 6 Lns 3-23; 36-39; Ln 55 - Col 7 Ln 6</p>

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>Col 7 Lns 9-18; 25-32; 33-54; Ln 55 – Col 8 Ln 9 Col 8 Lns 14-35; 38-56; 58 – Col 9 Ln 13 Col 9 Lns 14-28; 14-28; 36-44</p> <p>Figures 1-7</p> <p>U.S. Patents Nos. 5,029,185; 3,988,677; 4,677,624; 4,677,625.</p> <p>Prosecution History: December 21, 1992 <i>Amendment</i>, at pgs. 2-6; <i>Notice of Allowability</i>.</p>
<p>signal point (claims 9, 19)</p>	<p><u>Proposed construction</u></p> <p>A value that is transmitted by a modulator in one signaling interval</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract.</p> <p>Figures 1, 2, 3, 4, 5, 6 and 7</p> <p>Column 2, lines 5 – 50.</p> <p>Column 3, line 4 – column 4, line 51.</p> <p>Column 5, line 1 – column 6, line 26.</p> <p>Column 6, line 48 – column 9, line 51.</p> <p><u>Extrinsic Evidence</u></p> <p>U.S. Patent No. 5,559,561 (REM0086656-REM0086673)</p> <p>U.S. Patent No. 5,706,312 (REM0086674-REM0086687)</p> <p>U.S. Patent No. 5,512,957 (REM0086636-REM0086655)</p>	<p>A single mapped point in a signal constellation.</p> <p><u>Extrinsic Evidence</u></p> <p>EDWARD A. LEE, DIGITAL COMMUNICATION 186-187 (1988).</p> <p>GILBERT HELD, DICTIONARY OF COMMUNICATIONS TECHNOLOGY 400 (2d ed. 1995) (“Signal constellation”).</p> <p>RICHARD D. GITLIN, ET AL., DATA COMMUNICATION PRINCIPLES 355-356 (1992).</p> <p>Wang, et al., U.S. Patent No. 5,052,000.</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand this claim term to mean.</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract</p> <p>Col 1 Lns 29-33; 54-58</p> <p>Col 2 Lns 5-13; 14-18; 21-28; 31-50; 53 – Col. 4 Ln. 3</p>

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>Col 3 Lns 4-10; 30-44; 56-60; 65 – Col 4 Ln 3 Col 4 Lns 4-11; 35-46 Col 5 Lns 24-41; 44 – Col 6 Ln 26 Col 6 Ln 48 – Col 8 Ln 9 Col 8 Lns 14-35; 38-56; 58 – Col 9 Ln 13 Col 9 Lns 14-28; 29-44; 45-49</p> <p>Figures 1-7</p> <p>U.S. Patents Nos. 5,029,185; 3,988,677; 4,677,624; 4,677,625.</p> <p>Prosecution History: December 21, 1992 <i>Amendment</i>, at pgs. 2-6; <i>Notice of Allowability</i>.</p>
<p>Distributed Viterbi decoder (claims 9, 19)</p>	<p><u>Proposed construction</u> A Viterbi decoder having multiple Viterbi decoding processes operating on separate portions of a stream of data to be decoded</p> <p><u>Intrinsic Evidence</u> Abstract. Figure 3, 4, 5, 6 and 7. Column 1, line 34 – column 2, line 20. Column 4, line 52 – column 5, line 41. Column 6, lines 12 – 26. Column 6, line 48 – column 8, line 13. Column 8, line 57 – column 9, line 28. Column 9, line 52 – column 10, line 3.</p> <p>Prosecution History, Office Action Response dated</p>	<p>Two or more structures operating in parallel employing the Viterbi algorithm.</p> <p><u>Intrinsic Evidence:</u> Abstract Col 1 Lns 29-33; 34-46; 59-65 Col 2 Lns 5-13; 14-18; 21-28; 31-50; 53 – Col. 4 Ln. 3 Col 6 Lns 12-26; 62-66 Col 8 Ln 58 – Col 9 Ln 13</p> <p>Figures 1, 3-4</p> <p>U.S. Patents Nos. 5,029,185; 3,988,677; 4,677,624; 4,677,625.</p> <p>Prosecution History: December 21, 1992 <i>Amendment</i>, at pgs. 2-6; <i>Notice of Allowability</i>.</p> <p><u>Extrinsic Evidence:</u></p>

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>December 21, 1992 at TKHR 0000886 – TKHR 0000890.</p> <p><u>Extrinsic Evidence</u></p> <p>U.S. Patent No. 4,677,625 (COMREM00669498-COMREM00669505)</p>	<p>MICROSOFT COMPUTER DICTIONARY 167 (5th ed. 2002) (“Distribute”).</p> <p>MERIAM-WEBSTER COLLEGIATE DICTIONARY 337 (10th ed. 2001) (“Distribute”).</p> <p>WIKIPEDIA, available at http://en.wikipedia.org. (“Viterbi decoder”).</p> <p>McGRAW-HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS 2265 (6th ed. 2003) (“Viterbi algorithm”).</p>
<p>means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols (claim 9)</p>	<p><u>Proposed construction</u></p> <p>Interpreted under 35 U.S.C. § 112, ¶ 6.</p> <p>Function: to reverse the process of interleaving performed in the transmitter to recover multiple streams of trellis encoded channel symbols from the interleaved signal points</p> <p>Structure: signal point deinterleaver 441 or switching circuit 431, or a software based deinterleaver or switching circuit, and equivalents</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract.</p> <p>Figures 4, 5, 6 and 7.</p> <p>Column 5, line 67 – column 6, line 26.</p> <p>Column 8, line 57 – column 9, line 13.</p> <p>Column 9, line 45 – column 10, line 3.</p> <p>Refer also to intrinsic evidence cited in support of the</p>	<p>Means plus function claim to be construed pursuant to § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Deinterleaving the interleaved signal points to recover the plurality of streams of trellis encoded channel symbols</p> <p><u>Structure:</u></p> <p>Figure 4 (Streams 456/442, Blocks 441/431, Elements 4411/4412); Figure 7 (Streams 456/442, Block 741, Elements 7411/7412/7413/7414); Col 2: Lns 39-42, 48-50; Col 5: Ln 67 - Col 6 Ln 20; Col 8: Ln 62 - Col 9 Ln 51.</p> <p><u>Intrinsic Evidence:</u> Refer to intrinsic evidence cited in support of the claim terms: “trellis encoded channel symbols”; signal points”; and “plurality of streams of trellis encoded channel symbols”.</p> <p>Prosecution History: December 21, 1992 <i>Amendment</i>, at pgs. 2-6; <i>Notice of Allowability</i>.</p>

'627 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	claim terms "trellis encoded channel symbol" and "signal point"	<p><u>Extrinsic Evidence:</u></p> <p>Extrinsic evidence cited above relating to component terms.</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.</p>

United States Patent No. 5,852,631

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
<p>physical layer (claims 1, 6, 10)</p>	<p><u>Proposed construction</u></p> <p>The physical layer is the lowest layer of the Open Systems Interconnect (OSI) seven layer model, and is concerned with establishing the mechanical, electrical, functional, and procedural connection between two modems.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract, FIGS 2-8; 1:23-2:39; 2:62-3:15; 3:34-58; 4:5-18; 5:42-11:27; claims 1, 2, 6, 7, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23, 1998.</p> <p><u>Extrinsic evidence</u></p> <p>Hubert Zimmermann, "OSI Reference Model—The ISO Model of Architecture for Open Systems Interconnection," IEEE Transactions on Communications, vol. 28, No. 4, April 1980, pp. 425-432 (REM0086902-REM0086909).</p> <p>Society of Cable Telecommunications Engineers, Cable-Tec Expo '98 (Denver Colorado, June 10-13, 1998)</p>	<p>The physical layer is the lowest layer of the Open Systems Interconnect (OSI) seven layer model, which is concerned with establishing the electrical and mechanical connection between two modems.</p> <p><u>Intrinsic Evidence:</u></p> <p>Abstract Col 1 Ln 62 – Col 2 Ln 11 Col 2 Lns 12-18; 33-39; 39-59; 62 – Col 3 Ln 21 Col 3 Lns 4-13; 24-61 Col 5 Lns 5-24 Col 6 Lns 24-36; 37-56; 66 – Col 7 Ln 29 Col 10 Lns 57-59, 63 – Col 11 Ln 10 Col 11 Lns 23-28; 33-42 Col 12 Lns 43-54 Col 13 Lns 23-41</p> <p>Figures 1-8</p> <p>U.S. Patents Nos. 4,905,282; 5,425,080; 5,710,761.</p> <p>Prosecution History: <i>Preliminary Amendment</i>, submitted on March 20, 1997, at pg. 2; <i>First Response With Amendments</i>, submitted on October 23, 1997, at pgs. 5-13; <i>Response to Final Rejection</i>, submitted on January 23, 1998, at pgs. 2-10; <i>Third Response</i>, submitted on April 23, 1998, at pg. 3; <i>Transmittal of New Drawings</i>, submitted on July 27, 1998; <i>Notice of Allowability</i>.</p> <p><u>Extrinsic Evidence:</u></p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>(COMREM 00982076-00982709).</p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (6th ed. 1996) (REM0086899-REM0086900) (definition of "physical layer").</p> <p>DSET, LNP Automation Solution: Local Service Management System (LSMS) for Comcast (December 8, 2004) (COMREM00960142-COMREM00960170).</p>	<p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONIC TERMS 203 (6th ed. 1996) ("Connection") (5th definition).</p>
<p>negotiated physical layer modulation (claims 1, 6, 10)</p>	<p><u>Proposed construction</u></p> <p>A physical layer modulation selected by a process permitting two modems supporting different physical layer modulations to agree on a physical layer modulation, in which one modem presents one or more options, and the other modem selects from among the presented options.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract, FIGS 2-8; 1:23-2:39; 2:62-3:15; 3:34-58; 4:5-18; 5:42-11:27; claims 1, 2, 6, 7, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23,</p>	<p>A physical layer modulation agreed upon between two modems after exchanging information at run time.</p> <p><u>Intrinsic Evidence:</u></p> <p>Abstract Col 1 Lns 17-21; 37-48; 49-51; 55-61; 62 – Col 2 Ln 11 Col 2 Lns 12-18; 33-39; 39-59; 62 – Col 3 Ln 21 Col 3 Lns 24-61 Col 6 Lns 24-39; 37-56; 66 – Col 7 Ln 2 Col 7 Lns 15-30 Col 8 Lns 23-41 Col 11 Lns 39-46</p> <p>Figures 1-8</p> <p>U.S. Patents Nos. 4,905,282; 5,425,080; 5,710,761.</p> <p>Prosecution History: <i>Preliminary Amendment</i>, submitted on March 20, 1997, at pg. 2; <i>First Response With Amendments</i>, submitted on October 23, 1997, at pgs. 5-13; <i>Response to Final Rejection</i>, submitted on January 23, 1998, at pgs. 2-10; <i>Third Response</i>, submitted on April 23, 1998, at pg. 3; <i>Transmittal of New Drawings</i>, submitted on</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>1998.</p> <p><u>Extrinsic evidence</u></p> <p>U.S. Patent No. 4,905,282 (REM0086910-REM0086924)</p> <p>U.S. Patent No. 5,491,720 (REM0086925-REM0086935)</p> <p>IEEE Std 802.3u-1995, § 28 (COMREM 671706-672120).</p> <p>Draft CEA-679-C, National Renewable Security Standard (NRSS) (COMREM50007474).</p> <p>Rembrandt incorporates by reference the intrinsic and extrinsic evidence cited for the term "physical layer modulation."</p>	<p>July 27, 1998; <i>Notice of Allowability</i>.</p> <p><u>Extrinsic Evidence:</u></p> <p>"Negotiation": When a connection is established between the virtual terminals in different systems, an initial dialogue is needed to establish the parameters that each will use during the transaction. This is known as the negotiation phase." GILBERT HELD, DICTIONARY OF COMMUNICATIONS TECHNOLOGY 285 (2d ed. 1995).</p> <p>"Negotiate": To confer with another or others in order to come to terms or reach an agreement To arrange or settle by discussion and mutual agreement. THE AMERICAN HERITAGE DICTIONARY OF THE ENGLISH LANGUAGE 1176 (4th ed. 2000).</p> <p>"Negotiate": to arrange for or bring about through conference, discussion, and compromise." MERIAM-WEBSTER COLLEGIATE DICTIONARY 775 (10th ed. 2001).</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand this claim term to mean.</p>
<p>physical layer modulation (claims 1, 6, 10)</p>	<p><u>Proposed construction</u></p> <p>A protocol that is concerned with establishing the mechanical, electrical, functional, and procedural connection between two modems.</p> <p>The physical layer is the lowest layer of the Open Systems Interconnect (OSI) seven layer model, and is concerned with establishing the mechanical, electrical, functional,</p>	<p>The process or protocol that defines how bits are translated into waveforms and transmitted at the physical layer.</p> <p>The physical layer is the lowest layer of the Open Systems Interconnect (OSI) seven layer model, which is concerned with establishing the electrical and mechanical connection between two modems.</p> <p><u>Intrinsic Evidence:</u></p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>and procedural connection between two modems.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract, FIGS 2-8; 1:23-2:39; 2:62-3:15; 3:34-58; 4:5-18; 5:42-11:27; claims 1, 2, 6, 7, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23, 1998.</p> <p><u>Extrinsic evidence</u></p> <p>Hubert Zimmermann, "OSI Reference Model—The ISO Model of Architecture for</p> <p>Open Systems Interconnection," IEEE Transactions on Communications, vol. 28, No. 4, April 1980, pp. 425-432 (REM0086902-REM0086909).</p> <p>Society of Cable Telecommunications Engineers, Cable-Tec Expo '98 (Denver Colorado, June 10-13, 1998) (COMREM 00982076-00982709).</p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (6th ed. 1996) (REM0086899-REM0086900) (definition of "physical layer").</p> <p>DSET, LNP Automation Solution: Local Service</p>	<p>Abstract</p> <p>Col 1 Lns 17-20; 37-48; 49-51; 55-61; 62 – Col 2 Ln 11</p> <p>Col 2 Lns 12-18; 29-38; 39-59; 62 – Col 3 Ln 21</p> <p>Col 3 Lns 24-61</p> <p>Col 4 Lns 41-44; 48-51, 56-58</p> <p>Col 5 Lns 8-10, 24-25, 33-34; 49 – Col 6 Ln 11</p> <p>Col 6 Lns 12-23; 24-56; 57-65</p> <p>Col 7 Lns 15-30; 35-38;</p> <p>Col 8 Lns 23-41; 48-51</p> <p>Col 9 Lns 4-8; 15-22; 32-34, 38-46; 54-57, Col 10 Lns 1-4</p> <p>Col 10 Lns 26-31; 57 – Col 11 Ln 10</p> <p>Col 11 Lns 30-46</p> <p>Col 12 Lns 45-50; 59-65</p> <p>Col 13 Lns 23-41</p> <p>Col 14 Lns 1-5</p> <p>Figures 1-8</p> <p>U.S. Patents Nos. 4,905,282; 5,425,080; 5,710,761.</p> <p>Prosecution History: <i>Preliminary Amendment</i>, submitted on March 20, 1997, at pg. 2; <i>First Response With Amendments</i>, submitted on October 23, 1997, at pgs. 5-13; <i>Response to Final Rejection</i>, submitted on January 23, 1998, at pgs. 2-10; <i>Third Response</i>, submitted on April 23, 1998, at pg. 3; <i>Transmittal of New Drawings</i>, submitted on July 27, 1998; <i>Notice of Allowability</i>.</p> <p><u>Extrinsic Evidence:</u></p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONIC TERMS 662 (6th ed. 1996) ("Modulation") (1st and 5th definitions).</p> <p>MICROSOFT COMPUTER DICTIONARY 346 (5th ed. 2002)</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	Management System (LSMS) for Comcast (December 8, 2004) (COMREM00960142-COMREM00960170).	("Modulation") (2nd definition). EDWARD A. LEE, DIGITAL COMMUNICATION 679 (1988). WILEY ENCYCLOPEDIA OF ELECTRICAL AND ELECTRONICS ENGINEERING 668 (John G. Webster, ed.) (1999). ANDREW S. TANENBAUM, COMPUTER NETWORKS 29-30 (3d ed. 1996). THE COMMUNICATIONS HANDBOOK 573 (Jerry D. Gibson, ed.) (1996).
link layer (claims 1, 3, 4, 6, 8, 9, 10)	<p><u>Proposed construction</u></p> <p>The link layer is the second lowest layer of the Open Systems Interconnect (OSI) seven layer model, and provides the functional and procedural means to transfer data between modems, and to detect and correct errors that can occur in the physical layer.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract; FIGS. 2-8; 1:23-61; 2:40-59; 2:62-3:15; 3:34-58; 4:5-18; 11:30-13:41; claims 1, 3, 4, 6, 7, 9, and 10</p> <p>Office Action of September 4, 1997 (TKHR00000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23, 1998.</p>	<p>The link layer is the second lowest layer of the Open Systems Interconnect (OSI) seven layer model, which performs error checking functions as well as error correction through frame retransmission.</p> <p><u>Intrinsic Evidence:</u></p> <p>Abstract Col 1 Lns 17-21; 27-48; 51-54; 55-61 Col 2 Lns 39-59; 62 – Col 3 Ln 21 Col 3 Lns 24-61 Col 6 Lns 57-65 Col 11 Lns 23-28; 30-51; 52-58; 59 – Col 12 Ln 8 Col 12 Lns 9-36, 36 – Col 13 Ln 4</p> <p>Figures 1-8</p> <p>U.S. Patents Nos. 4,905,282; 5,425,080; 5,710,761.</p> <p>Prosecution History: <i>Preliminary Amendment</i>, submitted on March 20, 1997, at pg. 2; <i>First Response With Amendments</i>, submitted on October 23, 1997, at pgs. 5-13; <i>Response to Final Rejection</i>, submitted on January 23,</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p><u>Extrinsic evidence</u></p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (6th ed. 1996) (REM0086897-REM0086898) (definition of "link layer").</p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (6th ed. 1996) (REM0086897-REM0086898).</p> <p>Hubert Zimmermann, "OSI Reference Model—The ISO Model of Architecture for Open Systems Interconnection," IEEE Transactions on Communications, vol. 28, No. 4, April 1980, pp. 425-432 (REM0086902-REM0086909).</p>	<p>1998, at pgs. 2-10; <i>Third Response</i>, submitted on April 23, 1998, at pg. 3; <i>Transmittal of New Drawings</i>, submitted on July 27, 1998; <i>Notice of Allowability</i>.</p> <p><u>Extrinsic Evidence</u>:</p> <p>EDWARD A. LEE, <i>DIGITAL COMMUNICATION</i> 679 (1988).</p> <p>WILEY <i>ENCYCLOPEDIA OF ELECTRICAL AND ELECTRONICS ENGINEERING</i> 668, 670 (John G. Webster, ed.) (1999).</p> <p>THE <i>COMMUNICATIONS HANDBOOK</i> 573 (Jerry D. Gibson, ed.) (1996).</p> <p>ANDREW S. TANENBAUM, <i>COMPUTER NETWORKS</i> 30 (3d ed. 1996).</p> <p>IEEE <i>STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONIC TERMS</i> 203 (6th ed. 1996) ("Connection") (5th definition).</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand this claim term to mean.</p>
<p>establishing said link layer connection based upon said negotiated physical layer modulation. (claims 1, 6, 10)</p>	<p><u>Proposed construction</u></p> <p>The link layer connection is established substantially instantaneously upon the completion of the physical layer negotiation, using information derived from the negotiated physical layer modulation.</p> <p><u>Intrinsic evidence</u></p> <p>Abstract; FIGS. 2-8; 1:23-61; 2:40-59; 2:62-3:15; 4:5-18;</p>	<p>Link layer: The link layer is the second lowest layer of the Open Systems Interconnect (OSI) seven layer model, which performs error checking functions as well as error correction through frame retransmission.</p> <p>Negotiated physical layer modulation: A physical layer modulation agreed upon between two modems after exchanging information at run time.</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>11:30-13:41; claims 1, 3, 4, 6, 7, 9, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23, 1998.</p> <p>Rembrandt incorporates by reference the definitions and intrinsic and extrinsic evidence cited above for "link layer" and "negotiated physical layer modulation."</p>	<p>Comcast does not believe that the rest of this term needs to be construed, but reserves its right to argue its ordinary meaning and to counter Rembrandt's proposed construction.</p>
<p>means for establishing a physical layer connection between said calling and said answer modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations (claim 6)</p>	<p><u>Proposed construction</u></p> <p>Interpreted under 35 U.S.C. § 112, ¶ 6.</p> <p>Function: Establishing a physical layer connection based on a negotiated physical layer modulation</p> <p>Structure: a modem configured to establish a physical layer connection based on a negotiated physical layer modulation.</p> <p><i>In the event the Court holds that the structure corresponding to the recited function must be an algorithm, Rembrandt designates the following alternative structures: FIG. 4, boxes labeled "Finish dialing and send Clack-cell signal (1500 & 1900)," "1680 Hertz," "800 Hertz," "Detect other answer signal"; "Perform modem</i></p>	<p>Means plus function claim to be construed pursuant to § 112, ¶ 6.</p> <p>Function:</p> <p>Establishing a physical layer connection based on a negotiated physical layer modulation.</p> <p>Structure:</p> <p>Figs. 4-9; Col. 8, Ln. 23-Col. 9, Ln. 8; Col. 9, Lns. 15-46; Col. 9, Ln. 47-Col. 10, Ln. 56.</p> <p>Intrinsic Evidence: Refer to intrinsic evidence cited in support of the claim terms: "physical layer connection"; "negotiated physical layer modulation"; "physical layer modulation"; "based on".</p> <p>Prosecution History: <i>Preliminary Amendment</i>, submitted on March 20, 1997, at pg. 2; <i>First Response With</i></p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p><i>startup and training</i>"; "Synchronize to alternative modulation standard"; <i>or</i> FIG. 5, boxes labeled "Clock signal received within two seconds," "Standard automode, send ans (2100 Hz)," "Send ANSqck (V.34 S signal)," "Perform Modem Startup and Training"; <i>or</i> FIG. 6, boxes labeled "Send Clqck-Central," "ANS detected?," "ETC1 (V.32bis training); "ANSam detected?," "V.34 startup," "ANSqck detected (1680)," "Startup under alternative standard"; <i>or</i> FIG. 7, boxes labeled "CI of V.34 detected," "V.34 send ANSam," "Clctcl detected," "ETC1 mode, send 'ans," "Clqck-cell detected (1500 & 1900)," "Send ANSqck-PSTN," "Send ANSqck (V.34 S signal) (1680 Hz)," "ETC2 Startup (Send S signal)."</p> <p><u>Intrinsic evidence</u></p> <p>Abstract, FIGS 1-9; 1:23-2:39; 2:62-3:15; 3:31-62; 4:5-18; 5:42-11:27; 13:42-14:19; claims 1, 2, 6, 7, and 10</p> <p>Office Action of September 4, 1997 (TKHR0000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23, 1998.</p> <p><u>Extrinsic evidence</u></p> <p>Testimony of Dr. V. Thomas Rhyme regarding the structures corresponding to the recited function.</p>	<p><i>Amendments</i>, submitted on October 23, 1997, at pgs. 5-13; <i>Response to Final Rejection</i>, submitted on January 23, 1998, at pgs. 2-10; <i>Third Response</i>, submitted on April 23, 1998, at pg. 3; <i>Transmittal of New Drawings</i>, submitted on July 27, 1998; <i>Notice of Allowability</i>.</p> <p><u>Extrinsic Evidence</u>:</p> <p>Extrinsic evidence cited above relating to component terms.</p> <p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	Rembrandt incorporates by reference its intrinsic and extrinsic support for the claim terms: "physical layer"; "negotiated physical layer modulation"; "physical layer modulation"; and "establishing said link layer connection based upon said negotiated physical layer modulation."	
<p>means for establishing said link layer connection based upon said negotiated physical layer modulation (claim 6)</p>	<p><u>Proposed construction</u></p> <p>Interpreted under 35 U.S.C. § 112, ¶ 6.</p> <p>Function: Establishing the link layer connection based upon the negotiated physical layer modulation</p> <p>Structure: a modem configured to establish the link layer connection based upon the negotiated physical layer modulation, or the equivalent</p> <p><i>In the event the Court holds that the structure corresponding to the recited function must be an algorithm, Rembrandt designates the following alternative structures: 11:39-46; 13:34-37.</i></p> <p><u>Intrinsic evidence</u></p> <p>Abstract; FIGS. 1-9; 1:23-61; 2:40-59; 2:62-3:15; 3:31-62; 4:5-18; 11:30-14:19; claims 1, 3, 4, 6, 7, 9, and 10</p> <p>Office Action of September 4, 1997 (TKHR00000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998 (TKHR0000136-TKHR0000143); Response of April 23,</p>	<p>Means plus function claim to be construed pursuant to § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Establishing link layer connection based upon negotiated physical layer modulation.</p> <p><u>Structure:</u></p> <p>Figs. 8-9; Col. 12, Ln. 55-Col. 13, Ln. 17; Col. 13, Lns. 34-41; Col. 13, Ln. 55-Col. 14, Ln. 9.</p> <p><u>Intrinsic Evidence:</u> Refer to intrinsic evidence cited in support of the claim terms: "negotiated physical layer modulation"; "physical layer modulation"; "based upon"; "link layer connection".</p> <p>Prosecution History: <i>Preliminary Amendment</i>, submitted on March 20, 1997, at pg. 2; <i>First Response With Amendments</i>, submitted on October 23, 1997, at pgs. 5-13; <i>Response to Final Rejection</i>, submitted on January 23, 1998, at pgs. 2-10; <i>Third Response</i>, submitted on April 23, 1998, at pg. 3; <i>Transmittal of New Drawings</i>, submitted on July 27, 1998; <i>Notice of Allowability</i>.</p> <p><u>Extrinsic Evidence:</u></p> <p>Extrinsic evidence cited above relating to component terms.</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>1998.</p> <p><u>Extrinsic evidence:</u></p> <p>Testimony of Dr. V. Thomas Rhyme regarding the structures corresponding to the recited function.</p>	<p>Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.</p>
<p>means for presetting link layer parameters of said link layer connection to pre-defined settings based on said negotiated physical layer modulation (claim 9)</p>	<p><u>Proposed construction</u></p> <p>Interpreted under 35 U.S.C. § 112, ¶ 6.</p> <p>Function: Presetting link layer parameters based on the negotiated physical layer modulation</p> <p>Structure: a modem configured to preset link layer parameters of the link layer connection to pre-defined settings based on the negotiated physical layer modulation, or the equivalent</p> <p><i>In the event the Court holds that the structure corresponding to the recited function must be an algorithm, Rembrandt designates the following alternative structures: 11:39-46; 13:34-37.</i></p> <p><u>Intrinsic evidence</u></p> <p>Abstract, FIGS. 1-9; 1:23-61; 2:40-59; 2:62-3:15; 3:31-62; 4:5-18; 11:30-14:19; claims 1, 3, 4, 6, 7, 9, and 10</p> <p>Office Action of September 4, 1997 (TKHR00000181-TKHR0000189); Response of October 23, 1997 (TKHR0000165-TKHR0000179); Office Action of November 21, 1997 (TKHR0000156-TKHR0000162); Response of January 22, 1998 (TKHR0000144-TKHR0000154); Office Action of February 19, 1998</p>	<p>Means plus function claim to be construed pursuant to § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Presetting link layer parameters based on negotiated physical layer modulation.</p> <p><u>Structure:</u></p> <p>Figs. 8-9; Col. 12, Ln. 55-Col. 13, Ln. 17; Col. 13, Lns. 34-41; Col. 13, Ln. 55-Col. 14, Ln. 9.</p> <p><u>Intrinsic Evidence:</u> Refer to intrinsic evidence cited in support of the claim terms: "link layer parameters"; "negotiated physical layer modulation"; "physical layer modulation"; "based on"; "link layer connection";</p> <p>Prosecution History: <i>Preliminary Amendment</i>, submitted on March 20, 1997, at pg. 2; <i>First Response With Amendments</i>, submitted on October 23, 1997, at pgs. 5-13; <i>Response to Final Rejection</i>, submitted on January 23, 1998, at pgs. 2-10; <i>Third Response</i>, submitted on April 23, 1998, at pg. 3; <i>Transmittal of New Drawings</i>, submitted on July 27, 1998; <i>Notice of Allowability</i>.</p> <p><u>Extrinsic Evidence:</u></p> <p>Extrinsic evidence cited above relating to component terms.</p>

'631 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	(TKHR0000136-TKHR0000143); Response of April 23, 1998. <u>Extrinsic evidence</u> Testimony of Dr. V. Thomas Rhyme regarding the structures corresponding to the recited function.	Expert opinion of Dr. Harry Bims regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.

United States Patent No. 4,937,819

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
application program[s] (claims 1, 14)	<p><u>Proposed construction</u> a computer program or process</p> <p><u>Intrinsic Evidence</u> Abstract; FIG. 5; 1:7-12; 1:14-25; 1:45-52; 1:56-62; 2:5-10; 2:26-34; 3:12-19; 4:53-61; 5:59-68; 6:49-51</p> <p><u>Extrinsic Evidence</u> The New IEEE Standard Dictionary of Electrical and Electronics Terms (5th Ed.)(1993)(definition of "application program") Newton's Telecom Dictionary (7th Ed.)(1991)(definition of "application" and "program") 11/7/06 Deposition of Wayne Moore (rough transcript) at 84:13-24 11/8/06 Deposition of Joseph King (rough transcript) at 39:10-43:12; 53:17-54:23; 55:18-57:6; 58:23-59:3; 125:8-126:17</p>	<p>A program designed to assist in the performance of a specific end-user task (e.g., word processing, accounting, or inventory management) in contrast to a program designed to perform management of or maintenance work on the system or system components.</p> <p><u>Intrinsic Evidence:</u></p> <p>'819 Patent Abstract; Figs. 2, 4-5; columns and lines 1:7-12; 1:14-33; 1:45-2:34; 2:56-60; 3:12-19; 3:21-24; 3:39-41; 3:50-56; 4:39-52; 4:55-61; 5:10-13; 5:24-26; 5:64-68; 6:43-48; 6:49-51; 6:66-67.</p> <p>'819 Prosecution History 9/26/88 Patent Application at 15-18 (REM 0055943-55946). 5/20/89 Office Action at 2 (REM 0055992). 8/30/89 Amendment at 2-4, 6 (REM 0056095-56097, 56099). 10/13/89 Office Action at 4 (REM 0056108). U.S. Patent No. 4,606,023 (Dragoo) (REM 0055999-56007). U.S. Patent No. 4,644,534 (Sperlich) (REM 0056112-56119).</p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>U.S. Patent No. 4,726,017 (Krum) (REM 0055979-55989).</p> <p><u>Extrinsic Evidence:</u></p> <p>MICROSOFT COMPUTER DICTIONARY 33 (5th ed. 2002) ("application program").</p> <p>MICROSOFT COMPUTER DICTIONARY 31 (5th ed. 2002) ("application").</p> <p>MICROSOFT COMPUTER DICTIONARY 544 (5th ed. 2002) ("utility").</p> <p>MICROSOFT COMPUTER DICTIONARY 544 (5th ed. 2002) ("utility program").</p> <p>WEBOPEDIA, available at http://www.webopedia.com/TERM/a/application.html (last visited Oct. 13, 2006) ("application").</p> <p>11/8/06 Deposition of Joseph King, at 39:10 – 43:12; 53:17 – 54:23; 125:8 – 126:15 (based on rough transcript)</p> <p>Expert opinion of Dr. Curtis Siller regarding what one of ordinary skill in the art would understand this claim term to mean.</p>
<p>dividing a period of a clock in said master unit into a number of subframes, dividing each subframe into a number of slots, each corresponding to transmission times for one</p>	<p><u>Proposed construction</u></p> <p>Ordinary meaning</p> <p><u>Intrinsic Evidence</u></p> <p>FIG. 5; 4:53-61; 5:10-23; 6:37-39; 6:49-51; claim 15</p> <p>11/8/06 Deposition of Joseph King (rough transcript) at</p>	<p>Dividing the network clock period into time units (subframes), each of which is used for transmission by a specified remote; and dividing each subframe into smaller time units (time slots), each of which is assigned at initialization to one application via non-packetized messages from the master.</p>

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<p>of said remote units, and assigning a slot to each of said application programs (claim 14)</p>	<p>54:24-67:19; 81:5-81:11; 107:19-119:16; 133:7-134:21</p>	<p><u>Intrinsic Evidence:</u></p> <p>'819 Patent</p> <p>Abstract; Figs. 1, 3, 5-7; columns and lines 1:45-2:34; 2:44-49; 2:60-3:24; 3:59-65; 4:53-5:67; 6:37-39; 6:49-57; 6:66-7:2; 7:11-14; 7:22-25; 7:40-44; 8:18-24.</p> <p>'819 Prosecution History</p> <p>9/26/88 Patent Application at 15-18 (REM 0055943-55946).</p> <p>5/20/89 Office Action at 3-7 (REM 0055993-55997).</p> <p>8/30/89 Amendment at 2-4, 7-11 (REM 0056095-56097, 56100-56104).</p> <p>10/13/89 Office Action at 3-6 (REM 0056107-56110).</p> <p>2/13/90 Amendment at 2-7 (REM0056173-56178).</p> <p>U.S. Patent No. 4,644,534 (Sperlich) (REM 0056112-56119).</p> <p>U.S. Patent No. 4,726,017 (Krum) (REM 0055979-55989).</p> <p><u>Extrinsic Evidence</u></p> <p>11/8/06 Deposition of Joseph King at 54:24 – 55:8; 59:17 – 63:7; 66:22 – 67:19; 117:8 – 119:9.</p>
<p>time slot assigned to each of said application programs (claim 1)</p>	<p><u>Proposed construction</u></p> <p>“time slot” means an interval of time during which data from an application program is transmitted; rest of</p>	<p>An interval of time is assigned at initialization to each application program.</p> <p><u>Intrinsic Evidence:</u></p>

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	<p>limitation is ordinary meaning</p> <p><u>Intrinsic Evidence</u> Abstract; 1:45-2:33; 2:68-3:11; 3:59-65; 4:53-66; 5:14-23; 5:40-56; 6:49-57; 6:66-7:14</p> <p><u>Extrinsic Evidence</u> The New IEEE Standard Dictionary of Electrical and Electronics Terms (5th Ed.)(1993)(definition of "timeslot") The Computer Glossary (6th Ed.)(1993)(definition of "time slot") Newton's Telecom Dictionary (7th Ed.)(1991)(definition of "time slot") 11/8/06 Deposition of Joseph King (rough transcript) at 54:24-67:19; 81:5-81:11; 107:19-119:16; 133:7-134:21</p>	<p>'819 Patent Abstract; Figs. 1, 3, 5-7; columns and lines 1:45-2:34; 2:44-49; 2:60-3:24; 3:59-65; 4:53-5:67; 6:37-39; 6:49-57; 6:66-7:2; 7:11-14; 7:22-25; 7:40-44; 8:18-24.</p> <p>'819 Prosecution History 9/26/88 Patent Application at 15-18 (REM 0055943-55946). 5/20/89 Office Action at 3-7 (REM 0055993-55997). 8/30/89 Amendment at 2-4, 7-11 (REM 0056095-56097, 56100-56104). 10/13/89 Office Action at 3-6 (REM 0056107-56110). 2/13/90 Amendment at 2-7 (REM0056173-56178). U.S. Patent No. 4,644,534 (Sperlich) (REM 0056112-56119). U.S. Patent No. 4,726,017 (Krum) (REM 0055979-55989).</p> <p><u>Extrinsic Evidence</u> 11/8/06 Deposition of Joseph King at 54:24 – 55:8; 59:17 – 63:7; 66:22 – 67:19; 117:8 – 119:9.</p>
reservation request generator (claim 2)	<p><u>Proposed construction</u> a device or process that adds to a message a request for additional time slots</p> <p><u>Intrinsic Evidence</u></p>	<p>At this time, Comcast does not believe this term requires construction, but provides the following proposed construction in response to Rembrandt's request to construe the term. A device or process that monitors messages from the</p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	Abstract, Figs. 2 & 4, element 54; 1:63-2:1; 2:18-26; 4:3-14; 4:53-61; 5:59-6:24; 6:66-:14 11/8/06 Deposition of Joseph King (rough transcript) at 133:7-134:21.	remote units to the master unit and sets reservation bits in them, if any of their fields exceeds a preset parameter limit. <u>Intrinsic Evidence:</u> '819 Patent Abstract, Figs. 8-9; columns and lines 1:45-2:34; 2:18-25; 2:50-51; 2:61-68; 3:7-11; 3:35-37; 3:59-65; 4:6-16; 4:57-61; 4:64-67; 5:57-6:24; 6:11-6:24; 6:57-63; 6:66-7:14. <u>Extrinsic Evidence:</u> IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 912 (6th ed. 1996) ("request message") (sole definition).
reservation request processor (claim 2)	<u>Proposed construction</u> a device or process for receiving and processing requests for additional time slots from a reservation request generator <u>Intrinsic Evidence</u> Abstract, Figs. 1 & 3, element 14; 1:63-2:1; 2:18-26; 3:7-11; 4:53-61; 5:59-6:24; 6:66-7:14 11/8/06 Deposition of Joseph King (rough transcript) at 133:7-134:21.	At this time, Comcast does not believe this term requires construction, but provides the following proposed construction in response to Rembrandt's request to construe the term. A device or process that can grant a request from a remote unit for more time slots in order for the remote unit to transmit a longer message. <u>Intrinsic Evidence:</u> '819 Patent Abstract, Figs. 8-9; columns and lines 1:45-2:34; 2:18-25; 2:50-51; 2:61-68; 3:7-11; 3:35-37; 3:59-65; 4:6-16; 4:57-61; 4:64-67; 5:57-6:24; 6:11-6:24; 6:57-63; 6:66-7:14. <u>Extrinsic Evidence:</u>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 912 (6th ed. 1996) ("request message") (sole definition).
<p>priority bit (claim 11)</p>	<p><u>Proposed construction</u> One or more communication bits that are used to convey the relative importance of the communication</p> <p><u>Intrinsic Evidence</u> FIG. 5; 1:63-2:1; 2:18-26; 2:68-3:6; 4:62-5:3; 5:10-23; 5:40-45; 5:59-6:24; 6:52-7:14</p> <p><u>Extrinsic Evidence</u> The New IEEE Standard Dictionary of Electrical and Electronics Terms (5th Ed.)(1993)(definition of "priority") Von Nostrand's Dictionary of Information Technology (3rd Ed.)(1989)(definition of "priority") Newton's Telecom Dictionary (7th Ed.)(1991)(definition of "priority")</p>	<p>A bit that defines the importance of a given remote unit relative to other remote units.</p> <p><u>Intrinsic Evidence:</u> '819 Patent Abstract; Figs. 5-9; columns and lines 1:45-2:34; 2:66-3:6; 4:62-5:24; 5:39-45; 5:53-6:24; 6:1-10; 6:53-7:14.</p>
<p>master network timing means with a period which is divided into a plurality of subframes, wherein each subframe is divided into said time slots, and each of said time slots is used as an interval in</p>	<p><u>Proposed construction</u> "master network timing means" is a clock for determining network timing or for delineating time into time slots; rest of limitation is construed according to ordinary meaning</p> <p><u>Intrinsic Evidence</u> claim 10; FIGS. 1 & 3, element 12; 2:60-3:6; 5:15-24;</p>	<p>This is a means-plus-function term subject to construction under 35 U.S.C. § 112, ¶ 6.</p> <p><u>Function:</u> Dividing the period into subframes, and the subframes further into time slots, and assigning a time slot to each application.</p>

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<p>which one of said application programs in said one of said remote units is assigned to transmit (claim 1)</p>	<p>6:32-42; claim 3</p> <p><u>Extrinsic Evidence</u></p> <p>Von Nostrand's Dictionary of Information Technology (3rd Ed.)(1989)(definition of "master clock")</p> <p>McGraw-Hill Dictionary of Scientific and Technologic Terms (4th Ed.)(1989) (definition of "master clock")</p> <p>The Computer Glossary (6th Ed.)(1993)(definition of "master clock")</p> <p>Newton's Telecom Dictionary (7th Ed.)(1991)(definition of "master clock")</p> <p>11/8/06 Deposition of Joseph King (rough transcript) at 54:24-67:19; 81:5-81:11; 107:19-119:16; 133:7-134:21</p> <p>Testimony of Dr. V. Thomas Rhynne regarding the meaning of this claim term</p> <p><i>Rembrandt does not believe this limitation is subject to construction under 35 U.S.C. § 112, ¶ 6. Nonetheless, Rembrandt reserves the right to argue that should this limitation be governed by § 112, ¶ 6, it should be construed as follows:</i></p> <p><i>Function: determining master network timing</i></p> <p><i>Structure: FIGS. 1 & 3, element 12; 2:60-3:6; 5:15-24; 6:32-42</i></p>	<p><u>Structure:</u></p> <ul style="list-style-type: none"> • Network Timing Control Processor 12. See '819 Patent at Figs. 1, 3; 2:60-3:6; 3:12-24; 5:15-24; 5:29-34. <p><u>Intrinsic Evidence:</u></p> <p>'819 Patent</p> <p>Abstract; Figs. 1, 3, 5-9; columns and lines 1:45-2:34; 2:44; 2:66-3:24; 3:59-65; 4:53-6:24; 6:37-39; 6:49-7:14; 7:22-25; 7:40-44.</p> <p>8/30/89 Amendment at 2, 8-9 (REM 0056095, 56101-56102).</p> <p>10/13/89 Office Action at 2-4 (REM 0056106-56108).</p> <p>2/13/90 Amendment at 2, 6-7 (REM 0056173, 56177-56178).</p> <p>U.S. Patent No. 4,644,534 (Sperlich) (REM 0056112-56119).</p> <p><u>Extrinsic Evidence:</u></p> <p>Expert opinion of Dr. Curtis Siller regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.</p> <p>11/8/06 Deposition of Joseph King at 81:5 – 82:2.</p>
<p>ranging means communicating with said</p>	<p><u>Proposed construction</u></p>	<p>This is a means-plus-function term subject to construction</p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
master network timing means wherein a transmission time between said master unit and each of said respective remote units is calculated and transmitted from said master unit to each of said respective remote units (claim 1)	<p>"ranging means" is a device or process that determines a transmission time between the master unit and a remote unit; rest of limitation is construed according to ordinary meaning</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract; FIGS 1 & 3, elements 12, 20, 32; 1:63-2:17; 2:57-3:6; 3:25-29; 3:42-49; 4:62-5:3; 5:24-34; 6:32-36</p> <p><u>Extrinsic evidence</u></p> <p>Testimony of Dr. V. Thomas Rhyme regarding the meaning of this claim term</p> <p>11/8/06 Deposition of Joseph King (rough transcript) at 69:5-10</p> <p><i>Rembrandt does not believe this limitation is subject to construction under 35 U.S.C. § 112, ¶ 6. Nonetheless, Rembrandt reserves the right to argue that should this limitation be governed by § 112, ¶ 6, it should be construed as follows:</i></p> <p><i>Function: (performing) ranging</i></p> <p><i>Structure: FIGS 1 & 3, elements 12, 20, 32; 1:63-2:17; 2:57-3:6; 3:25-29; 3:42-49; 4:62-5:3; 5:24-34; 6:32-36;</i></p>	<p>under 35 U.S.C. § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Calculating and transmitting to each remote the time it takes to transmit between the master and that remote.</p> <p><u>Structure:</u></p> <ul style="list-style-type: none">• Network Timing and Control Processor 12. <i>See</i> '819 Patent at Figs. 1, 3; 3:12-24; 5:14-33.• Aggregate Rate Multiplexer 16. <i>See</i> '819 Patent at Figs. 1, 3; 3:12-24.• Ranging and Network Initialization Generator 20. <i>See</i> '819 Patent at Figs. 1, 3; 3:12-19.• Time Division Multiplexed Modulator 22. <i>See</i> '819 Patent at Figs. 1, 3; 3:19-24; 3:50-52.• Equalizer 24. <i>See</i> '819 Patent at Figs. 1, 3; 3:30-33; 4:17-18; 4:20-26; 5:34-38.• Automatic gain control 26. <i>See</i> '819 Patent at Figs. 1, 3; 3:33-34; 4:20-31; 5:34-38.• Demodulator 28. <i>See</i> '819 Patent at Figs. 1, 3; 3:33-38.• Ranging receiver 32. <i>See</i> '819 Patent at Figs. 1, 3; 3:35-38; 3:42-45; 4:20-26. <p><u>Intrinsic Evidence:</u></p> <p>'819 Patent</p>

'819 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>Abstract; Figs. 1, 3, 7; columns and lines 1:45-2:34; 3:12-38; 3:42-45; 3:50-52; 3:65-4:2; 4:17-18; 4:20-31; 5:1-3; 5:14-56; 5:46-52; 6:32-36.</p> <p>'819 Prosecution History</p> <p>9/26/88 Patent Application at 15-18 (REM 0055943-55946).</p> <p>5/20/89 Office Action at 2, 4-5 (REM 0055992, 55994-55995).</p> <p>8/30/98 Amendment at 2, 6, 8-10 (REM 0056095, 56099, 56101-56103).</p> <p>10/13/89 Office Action at 2-4 (REM 0056106-56108).</p> <p>2/13/90 Amendment at 2, 6-7 (REM 0056173, 56177-56178).</p> <p>U.S. Patent No. 4,606,023 (Dragoo) (REM 0055999-56007).</p> <p>U.S. Patent No. 4,644,534 (Sperlich) (REM 0056112-56119).</p> <p>U.S. Patent No. 4,726,017 (Krum) (REM 0055979-55989).</p> <p><u>Extrinsic Evidence:</u></p> <p>Expert opinion of Dr. Curtis Siller regarding what one of ordinary skill in the art would understand to be the structures disclosed in the patent specification corresponding to this means-plus-function claim term.</p>

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means for calculating clock drifts of the remote units and issuing reset commands to correct the same (claim 12)	<p>Interpreted under 35 U.S.C. § 112, ¶ 6.</p> <p>Function: determining a drift time between the master clock and a remote clock and issuing one or more commands to correct the drift</p> <p>Structure: FIGS. 1 & 3, element 12; 2:57-68; 3:25-29; 7:15-20</p> <p><u>Extrinsic evidence</u></p> <p>Testimony of Dr. V. Thomas Rhyme regarding the structures corresponding to the recited function</p>	<p>This is a means-plus-function term subject to construction under 35 U.S.C. § 112, ¶ 6.</p> <p><u>Function:</u></p> <p>Determining any differences or skew between the master clock and the respective clock maintained by each remote unit, and issuing one or more commands to correct the drift.</p> <p><u>Structure:</u></p> <p>The patent specification does not disclose any structure corresponding to the “means for calculating clock drifts.”</p> <p><u>Intrinsic Evidence:</u></p> <p>‘819 Patent</p> <p>Abstract; Fig. 8; columns and lines 1:45-2:34; 2:61-68; 3:25-29; 5:1-3; 7:15-20.</p> <p>‘819 Prosecution History</p> <p>8/30/98 Amendment at 4, 6 (REM 0056097, 56099).</p> <p><u>Extrinsic Evidence:</u></p> <p>Expert opinion of Dr. Curtis Siller regarding whether one of ordinary skill in the art would understand the patent specification to disclose any structures corresponding to this means-plus-function claim term.</p> <p>11/8/06 Deposition of Joseph King at 81:5 – 82:2.</p>

United States Patent No. 5,719,858

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
time-division multiplexed bus (claims 1, 7, 9, 11, 15, 20)	<p><u>Proposed construction</u> a bus having a bandwidth partitioned into regular time slots, that is shared by two or more sources of data by limiting each source's transmission opportunities to discrete intervals of time</p> <p><u>Intrinsic Evidence</u> FIGS. 3 & 4, element 204; FIGS. 5 & 7; Abstract; 2:42-65; 3:39-61; 4:25-36; 5:43-6:5; 6:36-41; 6:52-64; 11:12-17</p> <p><u>Extrinsic Evidence</u> Dictionary of Computing (4th Ed.)(1996)(definition of "time division multiplexing") 11/8/06 Deposition of Joseph King (rough transcript) at 49:9-52:11</p>	<p>A group of one or more conductors that is shared among several users by allowing each user to use the bus for a given period of time in a defined, repeated sequence.</p> <p><u>Intrinsic Evidence:</u></p> <p>'858 Patent Abstract; Figs. 1-3, 5-7; columns and lines 1:6-12; 1:28-64; 2:15-39; 2:41-3:12; 3:25-27; 3:39-61; 4:25-36; 4:47-51; 4:56-6:5; 6:37-8:45; 9:17-38; 10:43-57; 11:3-37.</p> <p>'858 Prosecution History 7/31/95 Patent Application at 15-18 (REM 0056495-56498). 4/4/97 Office Action at 2-4 (REM 0056522-56524). 8/1/97 Amendment and Response to Office Action at 2-12 (REM 0056633-56643). 10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648). U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p><u>Extrinsic Evidence:</u> IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 1115 (6th ed. 1996) ("time division multiplexing (TDM)") (1st definition).</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 117 (6th ed. 1996) ("bus") (3rd definition).</p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).</p> <p>Expert opinion of Dr. Curtis Siller regarding what one of ordinary skill in the art would understand this claim term to mean.</p>
<p>portion of the [predefined] bandwidth (claims 1, 7, 9, 11, 15, 20)</p>	<p><u>Proposed construction</u> one or more time slots in a TDM frame assigned to a group of data sources; see below for "predefined bandwidth"</p> <p><u>Intrinsic Evidence</u> Abstract; 2:49-57; 4:56-62; 5:11-42; 6:15-24; 11:12-17</p>	<p>The part, but less than all, of the data transfer capacity of the bus that is allotted either to packet data or to synchronous data.</p> <p><u>Intrinsic Evidence:</u></p> <p>'858 Patent Abstract; Figs. 1-3, 5-7; columns and lines 1:6-3:12; 3:39-53; 4:37-5:42; 6:6-52; 11:3-37.</p> <p>'858 Prosecution History 7/31/95 Patent Application at 15-18 (REM 0056495-56498). 4/4/97 Office Action at 2-5 (REM0056522-56525). 8/1/97 Amendment and Response to Office Action at 2-12</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		(REM 0056633-56643). 10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648). U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551). <u>Extrinsic Evidence:</u> MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 905 (10th ed. 1993) ("portion") (1st and 3rd definitions). MICROSOFT COMPUTER DICTIONARY 50 (5th ed. 2002) ("bandwidth") (2nd definition). Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-85209). Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).
predefined bandwidth (claims 7, 9, 11)	<u>Proposed construction</u> a TDM frame with a fixed number of time slots <u>Intrinsic Evidence</u> Abstract; 2:49-57; 4:56-62; 5:11-42; 6:15-24; 11:12-17	Data transfer capacity fixed in advance of operation. <u>Intrinsic Evidence:</u> '858 Patent Abstract; Figs. 1-3, 5-7; columns and lines 1:6-3:12; 3:39-53; 4:37-5:42; 6:6-52; 11:3-37. '858 Prosecution History 7/31/95 Patent Application at 15-18 (REM 0056495-

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>56498).</p> <p>4/4/97 Office Action at 2-5 (REM0056522-56525).</p> <p>8/1/97 Amendment and Response to Office Action at 2-12 (REM 0056633-56643).</p> <p>10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648).</p> <p>U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p><u>Extrinsic Evidence:</u></p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 913 (10th ed. 1993) ("pre-") (1st definition).</p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 302 (10th ed. 1993) ("define") (2nd definition).</p> <p>MICROSOFT COMPUTER DICTIONARY 50 (5th ed. 2002) ("bandwidth") (2nd definition).</p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).</p>
<p>packet data (claims 1, 7, 9, 11, 15, 20)</p>	<p><u>Proposed construction</u> variable bit rate data</p>	<p>Data that is transmitted in packets.</p> <p><u>Intrinsic Evidence:</u></p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p><u>Intrinsic Evidence</u></p> <p>Abstract; 1:6-11; 1:17-26; 3:53-56</p> <p><u>Extrinsic Evidence</u></p> <p>Newton's Telecom Dictionary (7th Ed.)(1994)(definition of "VBR")</p> <p>Longman Illustrated Dictionary of Computer Science (1987) (definition of "asynchronous")</p> <p>Acampora at 2:22-32</p> <p>COMREM976690-977133</p> <p>11/7/06 Deposition of Wayne Moore (rough transcript) at 41:19-22</p>	<p>'858 Patent</p> <p>Abstract; Figs. 1-3, 5; columns and lines 1:6-11; 1:17-23; 1:28-29; 1:34-39; 2:41-3:12; 3:39-51; 4:4-6; 4:11-17; 4:19-28; 4:39-55; 4:56-5:42; 6:15-24; 6:34-36; 6:44-50; 7:13-20; 9:63-10:2; 10:11-30; 11:3-37; 12:20-29; 12:62-13:1.</p> <p>'858 Prosecution History</p> <p>7/31/95 Patent Application at 15-18 (REM 0056495-56498).</p> <p>4/4/97 Office Action at 2-4 (REM 0056522-56524).</p> <p>8/1/97 Amendment and Response to Office Action at 2-12 (REM 0056633-56643).</p> <p>10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648).</p> <p>U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p>U.S. Patent No. 5,463,624 (Hogg) (REM 0056585-56612).</p> <p><u>Extrinsic Evidence:</u></p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 740 (6th ed. 1996) ("packet") (1st definition).</p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 740 (6th ed. 1996) ("packet") (3rd definition).</p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		<p>ELECTRONICS TERMS 740 (6th ed. 1996) ("packet") (6th definition).</p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 740 (6th ed. 1996) ("packet") (7th definition).</p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 740 (6th ed. 1996) ("packet") (10th definition).</p> <p>MICROSOFT COMPUTER DICTIONARY 385 (5th ed. 2002) ("packet") (2nd definition).</p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).</p>
<p>synchronous data (claims 7, 9, 11)</p>	<p><u>Proposed construction</u> constant bit rate data</p> <p><u>Intrinsic Evidence</u> Abstract; 1:6-11; 1:17-26; 3:48-51</p> <p><u>Extrinsic Evidence</u> Newton's Telecom Dictionary (7th Ed.)(1994)(definitions of "synchronous", "synchronous data network", "CBR") Dictionary of Computing (4th Ed.)(1996)(definition of</p>	<p>Constant bit rate data that is not transmitted in packets.</p> <p><u>Intrinsic Evidence:</u></p> <p>'858 Patent Abstract; Figs. 1-3, 5; columns and lines 1:6-11; 1:17-23; 1:28-29; 1:34-39; 2:41-3:12; 3:39-51; 4:4-6; 4:11-17; 4:19-28; 4:39-55; 4:56-5:42; 6:15-24; 6:34-36; 6:44-50; 7:13-20; 9:63-10:2; 10:11-30; 11:3-37; 12:20-29; 12:62-13:1.</p> <p>'858 Prosecution History</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>"time division multiplexing")</p> <p>The New IEEE Standard Dictionary of Electrical and Electronics Terms (5th Ed.)(1993)(definition of "synchronous")</p> <p>Longman Illustrated Dictionary of Computer Science (1987) (definition of "synchronous")</p> <p>Von Nostrand Reinhold Dictionary of Information Technology (3rd Ed.)(1989)(definitions of "synchronous", "synchronous data network", "synchronous modem", "synchronous time division multiplexing", "synchronous transmission")</p> <p>Acampora at 2:22-32</p> <p>11/7/06 Deposition of Wayne Moore (rough transcript) at 41:14-18; 77:23-78:24</p>	<p>7/31/95 Patent Application at 15-18 (REM 0056495-56498).</p> <p>4/4/97 Office Action at 2-4 (REM 0056522-56524).</p> <p>8/1/97 Amendment and Response to Office Action at 2-12 (REM 0056633-56643).</p> <p>10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648).</p> <p>U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p>U.S. Patent No. 5,463,624 (Hogg) (REM 0056585-56612).</p> <p><u>Extrinsic Evidence:</u></p> <p>IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS 1075 (6th ed. 1996) ("synchronous") (1st definition).</p> <p>MICROSOFT COMPUTER DICTIONARY 38 (5th ed. 2002) ("asynchronous") (sole definition).</p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).</p>
distributed packet manager	<u>Proposed construction</u> a device, process or algorithm that is located within each	A decentralized mechanism that performs all the functions required to aggregate and synchronize packet data to the

'858 Patent Claim Terms (claims 1, 7)	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
	<p>packet data source, that controls how the packet data source accesses a portion of the bandwidth assigned to packet data</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract; FIG. 3, elements 216-n; FIG. 4, PACKET MANAGER; FIG. 6; FIG. 8; 2:53-3:12, 3:51-4:36; 4:56-5:10; 6:6-15; 6:41-10:42</p> <p><u>Extrinsic Evidence</u></p> <p>Von Nostrand Reinhold Dictionary of Information Technology (3rd Ed.)(1989)(definition of "distributed function")</p> <p>Dictionary of Computer and Internet Terms (5th Ed.)(1996)(definition of "distributed")</p> <p>The Computer Glossary (6th Ed.)(1993)(definition of "distributed function")</p> <p>11/7/06 Deposition of Wayne Moore (rough transcript) at 177:11-178:20</p>	<p>time-division multiplexed bus and to prevent packet collisions.</p> <p><u>Intrinsic Evidence:</u></p> <p>'858 Patent</p> <p>Abstract; Figs. 1-4, 8A-8C; columns and lines 1:6-3:12; 3:23-24; 3:34-36; 3:51-4:36; 4:56-5:10; 6:6-10:43.</p> <p>'858 Prosecution History</p> <p>8/1/97 Amendment and Response to Office Action at 2-12 (REM0056633-56643).</p> <p>10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648).</p> <p>U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p>U.S. Patent No. 5,463,624 (Hogg) (REM 0056585-56612).</p> <p><u>Extrinsic Evidence:</u></p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-85209).</p> <p>Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).</p>
allocate access to the allotted bandwidth among said packet data sources	<p><u>Proposed construction</u></p> <p>Controlling access by each of the packet data sources to</p>	<p>Apportion to each of the packet data sources sole permission to attempt to transmit in any one or more of the</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
<p>(claim 1)</p> <p>allocate access to the second portion of the predefined bandwidth among said packet data sources (claim 7)</p> <p>controlling [the] access by said packet data sources to the allocated portion of the bandwidth (claims 15, 20)</p>	<p>the portion of bandwidth previously assigned to packet data</p> <p><u>Intrinsic Evidence</u></p> <p>Abstract; FIGS. 6 & 8, 2:49-57; 2:66-3:3; 4:56-5:5; 6:6-14; 6:41-10:42</p> <p><u>Extrinsic Evidence</u></p> <p>Van Nostrand Reinhold Dictionary of Information Technology (3rd Ed.)(1989)(definition of "allocate")</p> <p>The Computer Glossary (6th Ed.)(1993)(definition of "allocate")</p> <p>Longman Illustrated Dictionary of Computer Science (1987) (definition of "allocate")</p> <p>11/7/06 Deposition of Wayne Moore (rough transcript) at 177:11-178:20</p>	<p>specified time slots allotted to packet data.</p> <p><u>Intrinsic Evidence:</u></p> <p>'858 Patent</p> <p>Abstract; Figs. 1-4, 8A-8C; columns and lines 1:6-3:12; 3:23-24; 3:34-36; 3:51-4:36; 4:56-5:10; 5:11-20; 5:30-32; 6:6-10:43.</p> <p>'858 Prosecution History</p> <p>8/1/97 Amendment and Response to Office Action at 2-12 (REM0056633-56643).</p> <p>10/1/97 Examiner's Statement of Reasons for Allowance at 1 (REM 0056648).</p> <p>U.S. Patent No. 4,763,321 (Calvignac) (REM 0056529-56551).</p> <p>U.S. Patent No. 5,463,624 (Hogg) (REM 0056585-56612).</p> <p><u>Extrinsic Evidence:</u></p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 30 (10th ed. 1993) ("allocate") (1st definition).</p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 6 (10th ed. 1993) ("access") (2nd definition).</p> <p>MERRIAM WEBSTER'S COLLEGIATE DICTIONARY 252 (10th ed. 1993) ("control") (2nd definition).</p> <p>Wayne Moore, "An Approach for Packet Transport in the MAC system" (3/15/94) (memorandum) (REM 0085208-</p>

'858 Patent Claim Terms	Plaintiff Rembrandt's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence	Defendant Comcast's Proposed Construction and Identification of Intrinsic and Extrinsic Evidence
		85209). Wayne Moore, "A Method for Packet Transport in the MAC system" (4/8/94) (memorandum) (REM 0085210-85213).
network access manager (claim 8) network access module (claim 26)	<u>Proposed construction</u> a device, process or algorithm for controlling the assignment of synchronous and packet data portions on a TDM bus, and for passing data between the bus and a network <u>Intrinsic Evidence</u> Abstract; FIG. 3, element 205; 1:12-26; 2:49-65; 3:39-48; 4:62-5:2; 5:11-20; 9:22-30;	At this time Comcast does not believe this term needs to be construed, but reserves its right to argue its ordinary meaning and to counter Rembrandt's proposed construction.

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

ORDER

ON THIS DAY came on to be heard Plaintiff Rembrandt Technologies, LP's
Unopposed Motion for Leave to Amend its P.R. 4-3 submission, and the Court is of the opinion
that the Motion should be GRANTED.

IT IS THEREFORE ORDERED that Plaintiff Rembrandt Technologies LP's
Unopposed Motion for Leave to Amend P.R. 4-3 is GRANTED.

AUS:3846602.1
52670.1

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

**JOINT MOTION TO EXTEND THE DEADLINE TO
COMPLY WITH PATENT RULE 4-4**

Pursuant to the Court's Order, dated October 4, 2006, the parties have been ordered to complete all discovery relating to claim construction by December 4, 2006, in compliance with Patent Rule 4-4. Rembrandt Technologies, LP ("Rembrandt") and Comcast Corporation; Comcast Cable Communications, LLC; and Comcast of Plano, LP ("Comcast") jointly move the Court for an order extending the deadline for the parties to comply with Patent Rule 4-4 to December 24, 2006.

Dated: December 4, 2006

Respectfully submitted,

FISH & RICHARDSON P.C.

By: /s/ Thomas A. Brown by permission Elizabeth L. DeRieux

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ATTORNEYS FOR DEFENDANTS
COMCAST CORPORATION, COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

CERTIFICATE OF SERVICE

I hereby certify that counsel of record who are deemed to have consented to electronic service are being served this 4th day of December, 2006, with a copy of this document via the Court's CM/ECF system per Local Rule CV-5(a)(3). Any other counsel of record will be served by electronic mail, facsimile transmission and/or first class mail on this same date.

/s/ Elizabeth L. DeRieux

Elizabeth L. DeRieux

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

ORDER

The Court, having considered the Joint Motion to Extend the Deadline to Comply with Patent Rule 4-4, concludes that the motion is well taken and should be GRANTED.

Accordingly, it is ORDERED that the new deadline for filing the parties P.R. 4-4 is December 24, 2006.

IT IS SO ORDERED.

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION, COMCAST
CABLE COMMUNICATIONS, LLC, and
COMCAST OF PLANO, LP

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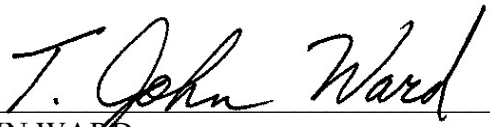
Civil Action No. 2:05-cv-443 [TJW]
JURY DEMANDED

**ORDER GRANTING TIME WARNER CABLE INC.'S
MOTION FOR ENTRY OF AMENDED PROTECTIVE ORDER**

Before the Court is Time Warner Cable Inc.'s Motion for Entry of Amended Protective Order. Having considered the Motion, the Court finds it is good and should be GRANTED.

IT IS THEREFORE ORDERED, that the Amended Protective Order be entered and that Time Warner Cable Inc. is bound by the terms and conditions of the Amended Protective Order with respect to any and all confidential information it may receive.

SIGNED this 7th day of December, 2006.



T. JOHN WARD
UNITED STATES DISTRICT JUDGE

**UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

REMBRANDT TECHNOLOGIES, LP	§	
	§	
v.	§	Civil Action No. 2:05-cv-443 [TJW]
	§	JURY DEMANDED
COMCAST CORPORATION, COMCAST	§	
CABLE COMMUNICATIONS, LLC, and	§	
COMCAST OF PLANO, LP	§	

AMENDED PROTECTIVE ORDER

WHEREAS, Plaintiff Rembrandt Technologies, LP (“Rembrandt”), Defendant Comcast Corporation (“Comcast”), and Intervenor Time Warner Cable Inc. (“TWC”) through counsel, stipulate to entry of this Protective Order (“Order”) pursuant to Fed. R. Civ. P. 26(c) to prevent unnecessary disclosure or dissemination of confidential information; and

WHEREAS, the parties and intervenor recognize that confidential information is being produced for use in this civil action;

IT IS HEREBY ORDERED that the following provisions of this Order shall govern the treatment of confidential information produced by a party (“Producing Party”) to any other party (“Receiving Party”) in the course of this civil action:

1. The term “Confidential Information” as used in this Order includes all information and tangible things that constitute or disclose trade secrets or other confidential or proprietary information of one of the parties. Confidential Information may be contained in discovery information or materials produced or obtained in this action by or through any means and by or through any person or entity. The Confidential Information contained therein and all copies, recordings, abstracts, excerpts, analyses or other writings that contain, reveal or otherwise disclose such Confidential Information shall also be deemed Confidential Information.

2. Confidential Information shall be disclosed, disseminated and used by the Receiving Party only for purposes of litigation between the parties to this action. Except with the prior written consent of the Producing Party or upon prior order of this Court, Confidential Information shall not be disclosed except in accordance with the terms, conditions, and restrictions of this Order.

3. Produced documents, interrogatory responses, responses to requests for admission and other documents containing “Confidential Information” shall be marked by conspicuously affixing a legend, which includes the words “CONFIDENTIAL,” or “HIGHLY CONFIDENTIAL—ATTORNEYS’ EYES ONLY”, as appropriate, on each page containing Confidential Information at the time such documents are produced or such information is disclosed (or on the cover or container of computer storage media, such as discs or tapes). The parties may designate material other than the produced documents as containing Confidential Information in the following manner:

(a) Testimony or information disclosed at a deposition that contains Confidential Information or Highly Confidential Information may be designated by indicating on the record at the deposition the portions of the testimony which contain such information that is to be made subject to the provisions of this Order. Alternatively, a Producing Party may designate testimony or information disclosed at a deposition, including exhibits, that contains Confidential Information or Highly Confidential Information by notifying all parties in writing, within fifteen (15) days after the Producing Party’s receipt of the transcript, of the specific pages and lines of the transcript that contain such information. Whether or not designation is made at the time of a deposition, accessibility to each transcript (and the information contained therein) of any deposition in its entirety shall be limited to outside counsel of record and designated in-

house counsel only, from the taking of the deposition until fifteen (15) days after actual receipt of the transcript by the Producing Party, or until receipt of the notice referred to in this paragraph, whichever occurs sooner. At the expiration of the said fifteen (15) day period, unless notice hereunder to the contrary is given at the time of the deposition or prior to the expiration of said period, the entire transcript shall be deemed non-confidential.

(b) Confidential Information or Highly Confidential Information contained in any affidavits, briefs, memoranda or other papers filed with the Court in this action may be designated as Confidential Information or Highly Confidential Information by indicating on the face of such documents that one or more parties considers them to contain such information.

4. The parties may designate as HIGHLY CONFIDENTIAL—ATTORNEYS' EYES ONLY any materials that qualify for protection under the standards developed under Fed. R. Civ. P. 26(c), but not including those materials which qualify for the designation "CONFIDENTIAL" under paragraph 5. Subject to the provisions of paragraphs 6 and 7 herein, material designated as HIGHLY CONFIDENTIAL—ATTORNEYS' EYES ONLY, and any summary, description or report of the information contained in such materials, may be disclosed only to the following persons:

(a) the Court, persons employed by the Court, and stenographers transcribing the testimony or argument at a hearing, trial or deposition in this action or any appeal therefrom;

(b) technical and damages consultants and experts who are not current employees of any party in this matter and who have been retained by counsel to provide assistance in this action, with disclosure only to the extent necessary to perform such work;

(c) graphics, translation, design and/or trial consulting services, including mock jurors, retained by a party;

(d) photocopy, document imaging and database services and consultants retained by counsel to set up, maintain and/or operate computer systems, litigation databases or to convert data for inclusion in such databases;

(e) John Meli, Executive Vice President and General Counsel of Rembrandt, and one in-house counsel employed by Comcast (following identification and approval by Rembrandt, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting each of those two individuals;

(f) John Steele of Fish & Richardson, P.C. and one additional Fish & Richardson, P.C. attorney (following identification and approval by Time Warner Cable Inc. and Comcast, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting them;

(g) with respect to the pleadings and papers, including any declarations or exhibits attached thereto, related to Time Warner Cable's Motion to Intervene and Motion to Disqualify: Andrew T. Block, Vice President and Chief Counsel of Intellectual Property at Time Warner Cable Inc. and one additional in-house counsel employed by Time Warner Cable Inc. (following identification and approval by Rembrandt and Comcast, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting them; John Meli, Executive Vice President and General Counsel for Rembrandt, and Barry Ungar, in-house counsel for Rembrandt, and two (2) paralegals and/or clerical employees assisting them; and Michael Aronoff, Senior Counsel for Comcast, and Lee Zieroth, Vice President and Deputy General Counsel for Comcast, and two (2) paralegals and/or clerical employees assisting them; and

(h) the parties' outside counsel of record in this action as specifically set forth below and any other counsel for a party that appears in this action, and their paralegal assistants, law clerks, stenographic and clerical employees who are assisting in the prosecution, defense and/or appeal of this action. Any individual outside counsel of record who receives information designated HIGHLY CONFIDENTIAL—ATTORNEYS' EYES ONLY may not participate in patent prosecution for the Receiving Party, and the individual outside counsel who receives any such information may not discuss the information with anyone involved in patent prosecution for the Receiving Party. Outside counsel of record for the parties are as follows:

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5. The parties may designate as CONFIDENTIAL any materials of a financial or accounting nature that qualify for protection under the standards developed under Fed. R. Civ. P. 26(c). Subject to the provisions of paragraphs 6 and 7 herein, material designated as CONFIDENTIAL, and any summary, description or report of the information contained in such materials, may be disclosed only to the following persons:

- (a) the Court, persons employed by the Court, and stenographers transcribing the testimony or argument at a hearing, trial or deposition in this action or any appeal therefrom;
- (b) technical and damages consultants and experts who are not current employees of any party in this matter and who have been retained by counsel to provide assistance in this action, with disclosure only to the extent necessary to perform such work;
- (c) graphics, translation, design and/or trial consulting services, including mock jurors, retained by a party;
- (d) photocopy, document imaging and database services and consultants retained by counsel to set up, maintain and/or operate computer systems, litigation databases or to convert data for inclusion in such databases;

(e) John Meli, Executive Vice President and General Counsel of Rembrandt, and one in-house counsel employed by Comcast (following identification and approval by Rembrandt, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting each of those two individuals;

(f) John Steele of Fish & Richardson, P.C. and one additional Fish & Richardson, P.C. attorney (following identification and approval by Time Warner Cable Inc. and Comcast, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting them;

(g) with respect to the pleadings and papers, including any declarations or exhibits attached thereto, related to Time Warner Cable's Motion to Intervene and Motion to Disqualify: Andrew T. Block, Vice President and Chief Counsel of Intellectual Property at Time Warner Cable Inc. and one additional in-house counsel employed by Time Warner Cable Inc. (following identification and approval by Rembrandt and Comcast, such approval not to be unreasonably withheld); and two (2) paralegals and/or clerical employees assisting them; John Meli, Executive Vice President and General Counsel for Rembrandt, and Barry Ungar, in-house counsel for Rembrandt, and two (2) paralegals and/or clerical employees assisting them; and Michael Aronoff, Senior Counsel for Comcast, and Lee Zieroth, Vice President and Deputy General Counsel for Comcast, and two (2) paralegals and/or clerical employees assisting them; and

(h) the parties' outside counsel of record in this action as specifically set forth in paragraph 4(h) and any other counsel for a party that appears in this action, and their paralegal assistants, law clerks, stenographic and clerical employees who are assisting in the prosecution, defense and/or appeal of this action.

6. (a) A party may exclude from a deposition any person who is not entitled to view Confidential Information or Highly Confidential Information when such information is the subject of examination.

(b) No Confidential Information or Highly Confidential Information shall be revealed or disclosed, in whole or in part, directly or indirectly, to any individual described in subparagraphs 4(b)-(g) and 5(b)-(g) until that individual has been given a copy of this Order and has duly completed and signed an undertaking in the form attached hereto as Exhibit A, the original of which shall be retained, until the conclusion of this action including all appeals, by counsel for each party who intends to or does disclose to such individual any Confidential Information or Highly Confidential Information.

(c) Before individuals under subparagraphs 4(b) and 5(b) may have access to Confidential Information or Highly Confidential Information, the Receiving Party must submit to the Producing Party the individual's signed undertaking as well as the individual's curriculum vitae setting forth his or her name, address, qualifications and relevant work experience, including, but not limited to, the identity of any company in the telecommunications industry for whom said individual has consulted or worked during the last five (5) years. If the Producing Party does not object in writing, within five (5) business days from receipt of the undertaking, Confidential Information or Highly Confidential Information may then be disclosed to the retained consultant or former employee. If timely objection is made, the parties shall attempt in good faith to resolve the disclosure issue. If the issue cannot be resolved, the Producing Party has fifteen (15) days from receipt of the undertaking to bring a motion to preclude the retained consultant or former employee from viewing the Producing Party's Confidential Information or Highly Confidential Information. If the Producing Party does not bring such a timely motion,

Confidential Information or Highly Confidential Information may be disclosed to the retained consultant or former employee.

(d) Pursuant to subparagraph 6(c), the disclosure of the identity of a consulting expert will not be a waiver of any privilege or right to withhold from production that applies to communications or work product. Furthermore, the parties agree that by stipulating to the entry of this Protective Order, the parties do not intend to modify in any way the normal discovery rules applicable to consulting experts, or other agreements reached between the parties regarding such discovery.

7. In addition to the terms set forth in paragraphs 4 through 6 herein governing the disclosure of Confidential Information or Highly Confidential Information, information or materials that contain, embody, or otherwise reflect a party's source code shall be provided the following further protections:

(a) Any and all such source code, except for hard (non-electronic) copies, shall be stored and viewed only at the offices of one (1) agreed-upon source code custodian ("Source Code Custodian") located in one of the following locations:

Wilmington, Delaware; Boston, Massachusetts; or Austin, Texas.

(b) Subject to subparagraphs (c) and (d), any source code produced in electronic form shall be stored and viewed only at the offices of the Source Code Custodian and shall be maintained in a secured, locked area. No electronic copies of source code shall be made. Any such source code shall only be viewed or analyzed on a stand-alone computer (a computer that is not connected to any internal or external computer or computer network) located within the above-described locations. The Source Code Custodian shall maintain a Source Code Access Log identifying for each and every time any source code is viewed, accessed or analyzed: (1) the

name of each person who accessed the code; (2) the date and time of access; (3) the length of time of access; and (4) whether any hard (non-electronic) copies of any portion of the code were copied and the portion of the code copied. The Receiving Party reviewing source code shall be allowed to make hard (non-electronic) copies of material that they, in good faith, consider relevant. The parties shall negotiate reasonable limitations on the amount of source code that is released by Producing Party at any given time.

(c) Any hard (non-electronic) copies of source code shall be stored and viewed only within the United States at:

(i) a secured, locked area in one of the offices of the Source Code Custodian, each such location within the United States, provided the hard (non-electronic) copies are marked with the designation “HIGHLY CONFIDENTIAL—ATTORNEYS’ EYES ONLY”;

(ii) the Court;

(iii) the site where any deposition relating to the source code is taken;

(iv) any intermediate location reasonably necessary to transport the information (e.g., a hotel prior to the deposition).

(d) For each and every hard (non-electronic) copy of any source code, or any portion of any source code, the Source Code Custodian shall maintain a log detailing the location of the copy. Excessive reproduction of source code should be avoided

(e) Prior to the Receiving Party taking possession of a hard (non-electronic) copy of source code as provided for under this paragraph, the Receiving Party shall inform the Producing Party as to specifically what portions of source code it plans to take into its possession. The Producing Party shall then have twenty-four (24) hours if informed on a weekday, or seventy-two (72) hours if informed on a weekend in which to object in writing to

the Receiving Party as to the extent or relevance of the source code the reviewing party seeks to possess. If objection is made, the parties shall meet and confer in good faith within three (3) business days and attempt to resolve the objection. If the objection is not resolved, the Producing Party shall have five (5) business days after the conference to file a motion with the Court for relief from production of the subject portions of source code. The subject portions of source code shall be retained by the Producing Party, pending the court's resolution of the motion.

(f) To the extent any source code becomes an exhibit to a deposition, one copy of the exhibit may be maintained at the U.S. office of outside counsel of record for each party in a secure, locked area. Counsel shall not designate source code as an exhibit solely for authentication purposes and shall only designate as an exhibit that portion of source code reasonably necessary for questioning.

8. Designation of Confidential Information or Highly Confidential Information as "HIGHLY CONFIDENTIAL—ATTORNEYS' EYES ONLY" or "CONFIDENTIAL" shall constitute a representation that such information has been reviewed by an attorney for the Producing Party and that there is a valid basis for such designation. Subject to the conditions set forth in Paragraph 7, Confidential Information or Highly Confidential Information shall be maintained by the Receiving Party under the overall supervision of outside counsel. The attorneys of record for the parties shall exercise best efforts to ensure that the information and documents governed by this Protective Order are (i) used only for the purposes set forth herein, and (ii) disclosed only to authorized persons. Moreover, any person in possession of Confidential Information or Highly Confidential Information shall exercise reasonably appropriate care with regard to the storage, custody or use of such Confidential Information or

Highly Confidential Information in order to ensure that the confidential or restricted nature of the same is maintained.

9. It is the intention of this Protective Order that the following categories of information shall not be and should therefore not be designated as Confidential Information or Highly Confidential Information: (a) any information that at the time of its disclosure in this action is part of the public domain by reason of publication or otherwise; (b) any information that after its disclosure in this action has become part of the public domain by reason of publication or otherwise through no act, omission or fault of the Receiving Party; (c) any information that at the time of its disclosure in this action is rightfully in the possession of the Receiving Party, its trial counsel or any expert retained by or for the Receiving Party under no obligations of confidence to any third party with respect to that information; or (d) any information that after its disclosure in this action is rightfully received by the Receiving Party, its trial counsel or any expert retained by or for the Receiving Party under no obligations of confidence or otherwise from any third party having the right to make such disclosure. During the pendency of this action, any disputes as to whether information is confidential under the terms of this Order shall be resolved according to the procedure set forth in paragraph 10 hereof.

10. If a party disagrees with any Confidential Information or Highly Confidential Information designation, such party shall first make its objection known to the Producing Party and request a change of designation. The parties shall first try to dispose of such dispute in good faith on an informal basis. If the dispute cannot be resolved, the party challenging the designation may request appropriate relief from the Court no sooner than five (5) days following the service of a written notice of disagreement. The burden of proving that information has been properly designated as Confidential Information or Highly Confidential Information is on the

party making such designation. Until a determination by the Court, the information in issue shall be treated as Confidential Information or Highly Confidential Information and subject to the terms of this Order. Any failure to object to any material being designated as Confidential Information or Highly Confidential Information shall not be construed as an admission by any non-designating party that the material constitutes or contains a trade secret or other confidential information.

11. During the course of preparing for a deposition or testimony, unless otherwise entitled to access under this Protective Order, a fact deponent/witness may be shown Confidential Information or Highly Confidential Information from another party's documents strictly limited to those documents which on their face reveal that they were authored or received by the deponent/witness in the normal course of business and outside the context of this litigation. This shall not preclude a Producing Party from showing documents that it has produced to its own witnesses and deponents, regardless whether the Producing Party has designated the document(s) it produced as Confidential, and regardless whether such person was the author or a recipient of the document.

12. At the deposition of a third party or former employee of a Producing Party, such third party or former employee of a Producing Party may be shown documents designated as Confidential only if the document was authored by or received by that third party or former employee.

13. Any person receiving Confidential Information or Highly Confidential Information shall not disclose such information to any person who is not entitled to receive such information under this Order. If Confidential Information or Highly Confidential Information is disclosed to any person not entitled to receive disclosure of such information under this Order,

the person responsible for the disclosure will inform counsel for the Producing Party and, without prejudice to other rights and remedies of any party, make a reasonable good faith effort to retrieve such material and to prevent further disclosure by the person who received such information.

14. Written material constituting or revealing Confidential Information or Highly Confidential Information, when filed with the Court in this action for any reason, shall be filed in sealed envelopes or other appropriate sealed containers on which shall be endorsed the title of this action, an indication of the nature of the contents of such sealed envelope or other container, a designation in the form set forth in paragraphs 4 or 5 hereof, and a statement substantially in the following form:

HIGHLY CONFIDENTIAL—ATTORNEYS' EYES ONLY
FILED UNDER SEAL PURSUANT TO COURT ORDER
Civil Action No. 2:05cv443-TJW

15. The Clerk of the Court is directed to place and maintain under seal in accordance with this Order any such pleading or other document filed with or delivered to this Court pursuant to Paragraph 14 or any other provision thereof.

16. Nothing herein shall prevent disclosure beyond the terms of this Order if the party producing Confidential Information or Highly Confidential Information consents in writing to such disclosure, or if the Court, after notice to all affected parties, orders or permits such disclosure.

17. The inadvertent production in discovery of any privileged or otherwise protected or exempted information, as well as the inadvertent production in discovery of information without an appropriate designation of confidentiality, shall not be deemed a waiver or impairment of any claim or privilege or protection including but not limited to the attorney-

client privilege, the protection afforded to work-product materials or the subject matter thereof, or the confidential nature of any such information, provided that the Producing Party shall promptly notify the Receiving Party in writing when inadvertent production is discovered. Upon receiving written notice from the Producing Party that privileged information or work-product material has been inadvertently produced, all such information, and all copies thereof, shall be returned to counsel for the Producing Party and the Receiving Party shall not use such information for any purpose until the Order of the Court.

18. Any violation of the terms of this Protective Order shall be punishable by money damages, interim or final injunctive or other equitable relief, sanctions, contempt of court citation, or such other or additional relief as deemed appropriate by the Court.

19. Until such time as this Protective Order has been entered by the Court, the parties agree that upon execution by the parties, it will be treated as though it had been "So Ordered."

20. Third parties who produce information in this action may avail themselves of the provisions of this Protective Order, and discovery materials produced by third parties shall then be treated by the parties in conformance with this Protective Order.

21. By entering this Order and limiting the disclosure of information in this case, the Court does not intend to preclude another court from finding that such information may be relevant and subject to disclosure in another case. Any person or party subject to this order that may be subject to a motion to disclose another party's information designated Confidential or pursuant to this order shall promptly notify that party of the motion so that it may have an opportunity to appear and be heard on whether that information should be disclosed.

22. In the event that any of the parties (a) is subpoenaed in another action, (b) is served with a demand in another action to which it is a party, or (c) is served with any other legal

process by a person not a party to this litigation, and is requested to produce or otherwise disclose discovery material that is designated as Confidential by another party, the party subpoenaed or served in accordance with this paragraph shall object to production of the Confidential material and shall give prompt written notice to the Producing Party. Should the person seeking access to the Confidential material take action against the party covered by this Order to enforce such a subpoena, demand or other legal process, it shall respond by setting forth the existence of this Order. Nothing in this Order shall be construed as requiring production of Confidential material covered by this Order.

23. (a) Within sixty (60) days after filing of the final judgment in this action, or, if such judgment is appealed from entry of a mandate affirming such final judgment, all Confidential Information or Highly Confidential Information shall be destroyed by all Receiving Parties or shall be returned to the Producing Party at the written election of the Producing Party which election shall be made within twenty days of the filing of the aforementioned final judgment or mandate. If any Receiving Party destroys any such Confidential Information or Highly Confidential Information, that party shall inform the Producing Party in writing.

(b) Notwithstanding the foregoing, one designated outside counsel of record for each party may maintain in its files one copy of each affidavit, affirmation, certification, declaration, brief record on appeal, notice of motion, deposition transcript, exhibit to a deposition or affidavit (or the like), exhibit at a hearing or trial, pleading, discovery request, stipulation, correspondence between counsel for the parties, written response to a discovery request or any other document filed with the Court and the court transcript, consisting of or containing Confidential Information or Highly Confidential Information. The Receiving Party shall be entitled to retain one copy, and outside counsel of record for each party shall be entitled to retain copies of any expert report

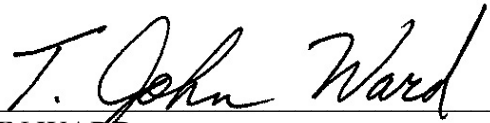
containing any Confidential Information or Highly Confidential information of the Producing Party, which is not in the public docket file. All such material shall remain subject to the terms of this Order.

24. This Order may be amended with leave of the Court by the agreement of counsel for the parties in the form of a stipulation that shall be filed in this action.

25. This Order shall remain in full force and effect until modified, superseded, or terminated on the record by agreement of the parties or by an Order of the Court.

26. At the conclusion of the present action, the Court shall retain jurisdiction to enforce the terms of this Order.

SIGNED this 7th day of December, 2006.



T. JOHN WARD
UNITED STATES DISTRICT JUDGE

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

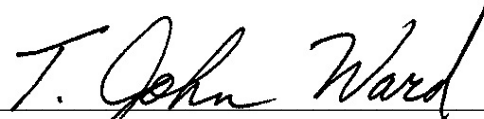
ORDER

The Court, having considered the Joint Motion to Extend the Deadline to Comply with Patent Rule 4-4, concludes that the motion is well taken and should be GRANTED.

Accordingly, it is ORDERED that the new deadline for filing the parties P.R. 4-4 is December 24, 2006.

IT IS SO ORDERED.

SIGNED this 7th day of December, 2006.



T. JOHN WARD
UNITED STATES DISTRICT JUDGE

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

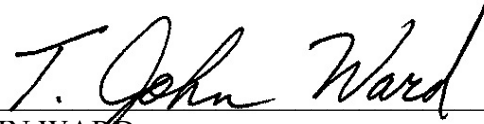
Civil Action No. 2:05-cv-00443-TJW

ORDER

ON THIS DAY came on to be heard Plaintiff Rembrandt Technologies, LP's
Unopposed Motion for Leave to Amend its P.R. 4-3 submission, and the Court is of the opinion
that the Motion should be GRANTED.

IT IS THEREFORE ORDERED that Plaintiff Rembrandt Technologies LP's
Unopposed Motion for Leave to Amend P.R. 4-3 is GRANTED.

SIGNED this 7th day of December, 2006.



T. JOHN WARD
UNITED STATES DISTRICT JUDGE

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52670.1

UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-CV-443-TJW

**PLAINTIFF REMBRANDT TECHNOLOGIES, LP'S REPLY TO DEFENDANTS'
FIRST AMENDED COUNTERCLAIMS**

Plaintiff Rembrandt Technologies, LP ("Rembrandt") hereby responds to the First Amended Counterclaims of Defendants Comcast Corporation ("Comcast Corp."), Comcast Cable Communications, LLC ("Comcast Cable"), and Comcast of Plano, LP ("Comcast of Plano") (collectively "Comcast") as follows. All allegations not expressly admitted are denied.

1. Rembrandt admits that Comcast Corp. is a corporation incorporated under the laws of Pennsylvania, having its principal place of business at 1500 Market Street, Philadelphia, Pennsylvania. Rembrandt admits that Comcast Cable is a corporation incorporated under the laws of Delaware having its principal place of business at 1500 Market Street, Philadelphia, Pennsylvania. Rembrandt admits that Comcast of Plano, LP is a limited partnership organized under the laws of Delaware. Rembrandt is without sufficient information to form a belief as to the truth of the remaining allegations in this paragraph.

2. Admitted.

3. Rembrandt admits that this Court has jurisdiction over Comcast's Counterclaims. The remaining allegations of this paragraph do not require a response.

4. Admitted.

5. Rembrandt admits that venue in this district is proper with respect to Comcast's Counterclaims.

FIRST COUNTERCLAIM FOR RELIEF

6. Rembrandt incorporates by reference its responses contained in Paragraphs 1 through 5 above.

7. Rembrandt admits that an actual controversy exists between the parties regarding U.S. Patent No. 5,243,627 (“the ‘627 patent”).

8. Paragraphs 1-30 of Comcast’s Answer do not require a response. In response to the allegations contained within paragraph 8 of Comcast’s Third Affirmative Defense, Rembrandt admits that the ‘627 patent, upon issuance, was assigned to AT&T Bell Laboratories. Rembrandt is without sufficient information to admit or deny the statements in Paragraph 9 of Comcast’s Third Affirmative Defense, and therefore they are denied. In response to the allegations contained within paragraph 20 of Comcast’s Fifth Affirmative Defense, Rembrandt admits that William Betts is a named inventor on U.S. Patent 4,677,626. Rembrandt denies all other allegations contained in Comcast’s Affirmative Defenses and in paragraph 8 of Comcast’s First Amended Counterclaims.

9. Denied.

10. Denied.

11. Denied.

12. Denied.

13. Denied.

SECOND COUNTERCLAIM FOR RELIEF

14. Rembrandt incorporates by reference its responses contained in Paragraphs 1 through 13 above.

15. Rembrandt admits that an actual controversy exists between the parties regarding U.S. Patent No. 5,852,631.

16. Rembrandt incorporates by reference its response to paragraph 8 of Comcast’s First Amended counterclaims.

17. Denied.

18. Denied.

19. Denied.

20. Denied.

THIRD COUNTERCLAIM FOR RELIEF

21. Rembrandt incorporates by reference its responses contained in Paragraphs 1 through 21 above.

22. Rembrandt admits that an actual controversy exists between the parties regarding U.S. Patent No. 5,719,858.

23. Rembrandt incorporates by reference its response to paragraph 8 of Comcast's First Amended counterclaims.

24. Denied.

25. Denied.

26. Denied.

27. Denied.

FOURTH COUNTERCLAIM FOR RELIEF

28. Rembrandt incorporates by reference its responses contained in Paragraphs 1 through 13 above.

29. Rembrandt admits that an actual controversy exists between the parties regarding U.S. Patent No. 4,937,819.

30. Rembrandt incorporates by reference its response to paragraph 8 of Comcast's First Amended counterclaims.

31. Denied.

32. Denied.

33. Denied.

34. Denied.

JURY DEMAND

This paragraph does not require a response.

PRAYER FOR RELIEF

Rembrandt incorporates by reference the Prayer for Relief set forth in Rembrandt's Complaint. Rembrandt denies that Comcast is entitled to any relief.

Dated: December 11, 2006

Respectfully submitted,

By: /s/ Andrew W. Spangler

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Counsel for Plaintiff
REMBRANDT TECHNOLOGIES, LP

CERTIFICATE OF SERVICE

I hereby certify that counsel of record who are deemed to have consented to electronic service are being served this 11th day of December, 2006, with a copy of this document via the Court's CM/ECF system per Local Rule CV-5(a)(3). Any other counsel of record will be served by electronic mail, facsimile transmission and/or first class mail on this same date.

/s/ Andrew W. Spangler
Andrew W. Spangler

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

PLAINTIFF'S UNOPPOSED MOTION FOR LEAVE TO EXCEED PAGE LIMITS

TO THE HONORABLE JUDGE OF SAID COURT:

COMES NOW Plaintiff, Rembrandt Technologies, LP, and files this Unopposed Motion for Leave to Exceed the Page Limits, and would show the Court as follows:

I.

Plaintiff respectfully moves the Court to permit Plaintiff to extend the page limits for its Claim Construction Brief from 30 pages to 35 pages. Plaintiff's Claim Construction Brief is attached hereto as Exhibit A.

WHEREFORE, PREMISES CONSIDERED, Plaintiff respectfully requests that the Court grant its Motion and permit Plaintiff to file its 35 page Brief, and for such other and further relief as Plaintiff may show itself justly entitled. This Motion is not brought for delay, but that justice might be done.

Dated: December 27, 2006

Respectfully submitted,

FISH & RICHARDSON P.C.

By: /s/ Thomas A. Brown by permission Andrew W. Spangler

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Attorneys for Plaintiff
REMBRANDT TECHNOLOGIES, LP

CERTIFICATE OF CONFERENCE

I hereby certify that on this 27th day of December, 2006, Plaintiff's counsel contacted counsel for Defendants regarding this Motion and Defendants do not oppose this Motion.

/s/ Andrew W. Spangler
Andrew W. Spangler

CERTIFICATE OF SERVICE

I hereby certify that counsel of record who are deemed to have consented to electronic service are being served this 27th day of December, 2006, with a copy of this document via the Court's CM/ECF system per Local Rule CV-5(a)(3). Any other counsel of record will be served by electronic mail, facsimile transmission and/or first class mail on this same date.

/s/ Andrew W. Spangler
Andrew W. Spangler

**UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

REMBRANDT TECHNOLOGIES, LP

Plaintiff,

v.

Civil Action No. 2:05-cv-00443-TJW

**COMCAST CORPORATION;
COMCAST CABLE
COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP**

Defendants.

**PLAINTIFF REMBRANDT TECHNOLOGIES, LP'S
CLAIM CONSTRUCTION BRIEF**

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Counsel for Plaintiff
REMBRANDT TECHNOLOGIES, LP

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I. FACTUAL BACKGROUND

This is a patent infringement action in which Rembrandt Technologies, L.P. (“Rembrandt”) has accused Comcast Corporation and certain of its subsidiaries (collectively “Comcast”) of infringing four United States Patents.

Rembrandt’s business involves obtaining value for the patented inventions of technology companies and individual inventors. The patents in suit here were previously owned by Paradyne Networks, Inc., which for decades has been a leading innovator in the field of high speed digital communications systems. Paradyne engineers have been awarded hundreds of patents, many of which reflect seminal developments in the field.

Comcast is one of the nation’s largest cable operators. Comcast provides cable internet services compliant with the so-called “DOCSIS” specification, which describes the operational parameters of certain telecommunications equipment including cable modems. Comcast also uses digital television equipment that complies with the so-called “ATSC” specification, which relates to the receipt and broadcast of digital television signals.

Three of the patents in suit, U.S. Patent No. 5,719,858 (the “858 patent”), U.S. Patent No. 4,937,819 (the “819 patent”), and U.S. Patent No. 5,852,631 (the “631 patent”), relate to improved methods for facilitating communication between modems. These three are infringed by Comcast’s cable Internet service. The fourth patent, U.S. Patent No. 5,243,627 (the “627 patent”), covers an improved technique for error correction in a digital transmission system. It is infringed by Comcast’s digital television service, specifically by Comcast’s reception of certain digital television signals.

II. DISCUSSION

A. Legal Standards

Claim construction is an issue of law. *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1581-82 (Fed. Cir. 1996). Intrinsic evidence – the patent claims, specification, and prosecution history – is the primary source of guidance as to the meaning of the claim terms. “The construction that stays true to the claim language and most naturally aligns with the

patent's description will be, in the end, the correct construction.” *Phillips v. AWH Corp.*, 415 F.3d 1303, 1316 (Fed. Cir. 2005) (*en banc*).

B. U.S. Patent No. 5,719,858

1. Patent Overview

Time Division Multiplexing (TDM) is a technique whereby multiple data sources may transmit data over a single network connection. The '858 patent relates to a mechanism that can allow two different types of data sources – “synchronous” data sources, which output data at a constant rate, and “packet” data sources, which output data at a “variable rate” – to agree among themselves how to allocate time slots on a single TDM bus. (Ex. 1 at 1:8-11.)

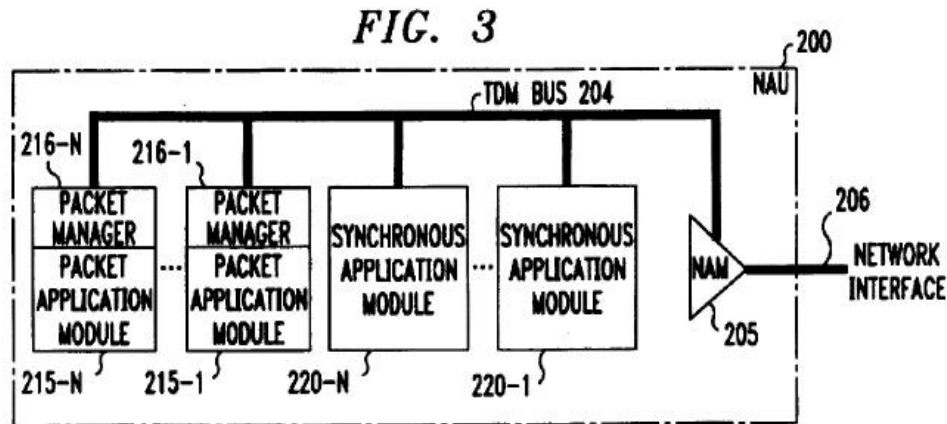
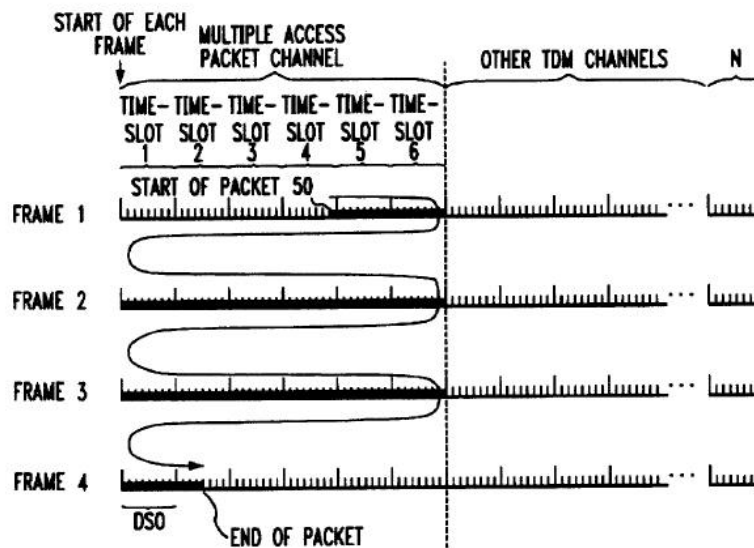


Figure 3 of the patent shows an exemplary TDM bus 204, having multiple “packet” data sources 215, and multiple “synchronous” data sources 220. In the embodiment of Figure 3, each “packet” data source 215 also includes a “distributed packet manager” 216, discussed below. The TDM bus is connected to a “network access manager” (“NAM”) 205, which (among other functions) connects the TDM bus 204 to a wider network. (*Id.* at 3:46-48.)

As best shown in Figure 5, the bandwidth of the TDM bus is partitioned into regular time slots, which help to delineate “channels” on the TDM bus. For each segment of time – called a “frame” – certain timeslots are reserved for the transmission of “packet” data. These timeslots form a “multiple access packet channel,” which acts as a single, common channel shared by the

packet sources. (*Id.* at 4:56-5:12.) The remaining timeslots form channels that are reserved for transmission of “synchronous” data. (*Id.* at 5:10-12.) Figure 5 shows, schematically, this division of the bandwidth. Time slots on the left-hand side are assigned to the multiple access packet channel, while time slots on the right-hand side are assigned to synchronous data channels:

FIG. 5



One aspect of the '858 patent relates to the mechanism for sharing the multiple access packet channel among the packet data sources. In certain embodiments of the '858 patent, this function is decentralized in the form of a “distributed packet manager” within each packet data source. (*Id.* at 6:6-14.)

The '858 patent includes a variety of independent claims that recite different facets of the invention. Most claims recite a TDM bus with one or more packet data sources or synchronous data sources, along with other features of the invention. Claim 1, for example, is directed to the use of a “distributed packet manager” to allocate the bandwidth among packet data sources. Claim 9, by contrast, does not recite a distributed packet manager, but instead requires that the bandwidth reserved for packet data is “shared in such a way that only one of the plurality of packet data sources accesses the second portion of the predefined bandwidth at a time.” (*Id.* at

12:52-54.) Similarly, claim 11 omits the “distributed packet manager” limitation, but recites circuitry between the packet data sources and the TDM bus, including a “counter for counting time-slots representing the second portion of the predefined bandwidth.” (*Id.* at 13:5-10.)

2. time-division multiplexed bus (claims 1, 7, 9, 11, 15, 20)

Construction: a bus having a bandwidth partitioned into regular time slots, that is shared by two or more sources of data by limiting each source’s transmission opportunities to discrete intervals of time

Rembrandt and Comcast agree that a TDM bus is one in which different sources of data share bandwidth. Comcast, however, asserts that use of the bus is granted in a “defined, repeated sequence.” This narrowing of the definition is clearly wrong. It is contrary to the teaching of the patent specification, and would exclude the preferred embodiment. *See Vitronics*, 90 F.3d at 1583 (a claim construction that excludes a preferred embodiment “is rarely, if ever, correct and would require highly persuasive evidentiary support”).

The ’858 patent expressly *contrasts* the invention with systems in which packet data sources access the bus in a regular, repeated sequence. “[The invention] is in contrast to allocating a fixed fraction of the TDM bandwidth to each packet application module.” (Ex. 1 at 4:61-62.) Figure 6, for example, shows a sequence in which Module 2 sends data, and then Module 6 sends data, skipping over the intervening packet data sources. (*Id.* at Fig. 6 & 7:25-9:15.) The only reason that Module 6 sends data after Module 2, in this instance, is that Modules 3 to 5 have no data to send. In another instance, Modules 3, 4 or 5 could have followed Module 2. Indeed, even Comcast’s expert testified that in the ’858 patent there is no repeated sequence by which packet data sources access the bus. (Ex. 7 at 51:11-52:2.) Comcast’s construction is clearly incorrect, and should be rejected.

By contrast, Rembrandt’s construction is consistent with the patent specification. Figure 5 shows TDM frames according to the invention. (Ex. 1 at 3:25-27.) Comcast’s expert agreed

that the frames include “individual time slots fix[ed] in size” for both the synchronous and packet data sources. (Ex. 7 at 48:9-49:17.)¹ Rembrandt’s construction should be adopted.

3. packet data (claims 1, 7, 9, 11, 15 and 20)

Construction: variable bit rate data

The ’858 patent claims recite a plurality of “packet data sources,” and the parties dispute the meaning of “packet data.” The meaning of this limitation should not be in dispute, however, because the ’858 patent specification includes an express definition of “packet data:”

The present invention relates to data communications, and more particularly to communications systems that have channelized network access, and may transport both synchronous data and *variable-bit-rate data* such as frame relay data (*hereafter referred to as packet data*), in a time-division multiplexed format.

(Ex. 1 at 1:8-11.)²

This express definition of “packet data” as “variable bit rate data” should be adopted. The definition is consistent with other disclosure from the specification. For example, in describing synchronous and packet data, the specification refers to the “asynchronous nature of packet data.” (*Id.* at 1:24.) Figure 5 also shows packet data that spans an irregular number of time slots (the thick black line spanning a number of frames on the left side of Figure 5).

It is axiomatic that where a patent provides an express definition of a claim term, that definition should be adopted. *See Jack Guttman, Inc. v. Kopykake Enters., Inc.*, 302 F.3d 1352, 1360-61 (Fed. Cir. 2002) (construing a claim term consistent with the express definition provided in the specification); *see also Vitronics*, 90 F.3d at 1582 (“The specification acts as a dictionary when it expressly defines terms used in the claims or when it defines terms by implication.”) Here there is no basis to stray from this definition. The term “packet data” was never an issue in prosecution, and there is no intrinsic evidence that contradicts this meaning.

¹ Citations to testimony of Comcast’s experts, Dr. Curtis Siller and Dr. Harry Bims, as well as the pages attached as Exhibits 7 and 8 are from the draft transcripts of each deposition.

² Unless otherwise indicated, emphasis in this Brief has been added.

4. **synchronous data (claims 7, 9 and 11)**

Construction: constant bit rate data

Synchronous data is contrasted with packet data in the '858 patent, and so should have a distinct meaning. The '858 patent states that it relates to systems having “two types of data: synchronous data and packet data.” (*Id.* at 1:20.) Whereas “packet data” refers to data with a variable bit rate, “synchronous data” should be construed to mean “constant bit rate data.” As set forth above, the patent itself sets out an express definition for packet data as “variable bit rate data.” This same intrinsic evidence supports a definition of synchronous data as “constant bit rate data.” Newton’s Telecom Dictionary defines synchronous as data transmissions with “a constant time between successive bits, characters or events.” (Ex. 24.) According to the patent, synchronous data supports “the ability to make telephone, i.e., voice calls.” (Ex. 1 at 1:20-22.) Voice calls require constant bit rate access to the bus to minimize gaps in the signal that might degrade the quality of the call. (*See* Ex. 24, defining CBR or constant bit rate as “processes such as voice that require a constant, repetitive or uniform transfer of information.”)

Comcast concedes that synchronous data is constant bit rate data – sent between a transmitter and receiver operating “continuously at the same rate” – but seeks to add the further restriction that synchronous data “is not included in a packet.” (*See* First Amended Joint Claim Construction and Prehearing Statement (“Joint Claim Construction Statement”) (Docket No. 112)³ at A-33.) This unsupported narrowing of the ordinary meaning of “synchronous” would read out a preferred embodiment. The '858 patent expressly ties synchronous data to telephone calls (*id.* at 1:20-22), and describes use of the invention with certain networks called ATM networks (*id.* at 11:18-36). Comcast’s expert Dr. Siller admitted that telephone calls over ATM networks would include voice data within packets called “cells.” (Ex. 7 at 59:12-61:15.) Comcast’s construction would read out this embodiment.

³ The parties intend to file a Second Amended Joint Claim Construction and Prehearing Statement with Rembrandt’s reply brief.

Comcast's proposed construction is even contradicted by its own extrinsic evidence. The IEEE definition on which Comcast relies states that "synchronous" entails "sending and receiving terminal equipment . . . operating continuously at the same rate." (Ex. 9.) It says nothing about whether or not packets may be used. Here both the intrinsic and extrinsic evidence support Rembrandt's construction, and it should be adopted. *Phillips*, 415 F.3d at 1316-17 (explaining that a claim term should be given its ordinary meaning unless the patentee clearly intended otherwise).

5. portion of the [pre-defined] bandwidth (claims 1, 7, 9, 11, 15, 20)

Construction: one or more time slots in a TDM frame assigned to a group of data sources

Both parties construe this element to relate to a portion of the bandwidth or frame that is assigned to a group of data sources (*e.g.*, packet data sources or synchronous data sources). The essence of the dispute here is whether a "portion" of the bandwidth must be less than the full bandwidth. Rembrandt's construction is consistent with the '858 patent, which never limits a "portion" to less than the full bandwidth. Indeed, the patent encompasses situations where both synchronous and packet sources are present on a TDM bus (and so neither would have the full bandwidth), and situations in which only packet sources are on a TDM bus (and so can take up the full bandwidth). The term "portion" encompasses both these embodiments,

The claims themselves evidence this breadth of scope. Claim 1, for example, recites only one type of data source, a packet data source, and allocates a "portion of the bandwidth" to packet data. In at least this claim (and its dependent claims), there are no other data sources, and so nothing to limit a "portion" to less than the full bandwidth. Comcast's construction is inconsistent with this plain reading of claim 1.

6. predefined bandwidth (claims 7, 9, 11)

Construction: a TDM frame with a fixed number of time slots

Because it relates to a TDM system, the '858 patent expressly ties bandwidth to a number of time slots. The Abstract, for example, states that a "portion of the bandwidth, or time-slots, of

the TDM bus is allocated” (Ex. 1 at Abstract.) Figure 5 shows the bandwidth partitioned into frames formed of a fixed number of time slots. (*Id.* at Fig 5.) A pre-defined bandwidth therefore has a fixed number of time slots in a frame, again as shown in Figure 5. Rembrandt’s definition is drawn directly from this intrinsic evidence.

7. distributed packet manager (claims 1, 7)

Construction: a device, process or algorithm that is located within each packet data source, that controls how the packet data source accesses a portion of the bandwidth assigned to packet data

Rembrandt’s construction of “distributed packet manager” captures its proper role in the ’858 invention. It is a process located within the various packet data sources (i.e., “distributed”) that manages how packet sources share the time slots that are reserved for packet data.

Rembrandt’s construction is consistent with the claim language itself, which simply recites that the distributed packet manager is configured to “allocate access to the allotted bandwidth among said packet data sources.” (Ex. 1 at 11:46-47.) It is also consistent with the specification, which broadly states that in the ’858 invention the “function of the packet manager is now distributed among the various packet application modules.” (*Id.* at 3:56-58.)

By contrast, Comcast seeks a construction of “distributed packet manager” that imposes a further requirement, namely that it “prevent packet collisions.” (*See* Joint Claim Construction Statement at A-34-35.) The ’858 patent claims establish that Comcast’s construction is wrong. Where the patentee chose to claim the concept of preventing collisions (a feature of the preferred embodiment) he did so explicitly, not using the generic “distributed packet manager” language.

Specifically, both claims 7 and 9 recite a plurality of packet data sources that “share [a] second portion of the predefined bandwidth for transmitting packet data.” (Ex. 1 at 12:24-29; 12:45-50.) Claim 9 further recites that this second portion is “shared in such a way that **only one** of the plurality of packet data sources accesses the second portion of the predefined bandwidth at a time.” (*Id.* at 12:51-54.) Claim 7, as with other “distributed packet manager” claims, does not require that “only one” packet data source access the bus at a time. Instead, it more broadly

recites a “distributed packet manager” that is “configured to allocate access to the second portion . . . among said packet data sources.” (*Id.* at 12:30-33.) In fact, ***no*** “distributed packet manager” claim includes any requirement that “only one” packet data source access the bus at a time. The “only one” language is what the patentee chose to express the concept of preventing packet collisions, and its omission from the “distributed packet manager” claims shows that the patentee did not intend to limit the “distributed packet manager” limitation in this way.

The specification also supports this distinction. In the Summary of the Invention, the distributed nature of the packet manager – i.e., that “no central packet manager is required” – is described separately from the feature of “avoid[ing] packet collisions.” (Ex. 1 at 2:66-3:1.) In the “Detailed Description” section, collision avoidance is likewise mentioned only when introducing a specific preferred embodiment. (*See id.* at 6:53-64.)

8. allocate access to the allotted bandwidth among said packet data sources [and corresponding limitations] (claims 1, 7, 15, 20)

Construction: controlling access by each of the packet data sources to the portion of bandwidth previously assigned to packet data

The dispute regarding these limitations parallels that concerning the distributed packet manager limitation. Here Comcast seeks to read in the limitation that a given packet data source has “sole permission” to transmit in a given time period, which is essentially the same concept as “preventing packet collisions” that Comcast seeks to read into the distributed packet manager claims. As with the distributed packet manager claims, ***no claim at issue here includes the express language used by the patentee to capture the notion of preventing packet collisions*** – that “only one” of the packet data sources accesses the bus at a given time. This express language only appears in independent claim 9, and reading that same feature into another limitation would be improper here. *See Tandon Corp. v. United States Int’l Trade Comm’n*, 831 F.2d 1017, 1023 (Fed. Cir. 1987) (“There is presumed to be a difference in meaning and scope when different words or phrases are used in separate claims.”)

9. network access manager; network access module (claim 8, 26)

Construction: a device, process or algorithm for controlling the assignment of synchronous and/or packet data portions on a TDM bus, and for passing data between the bus and a network

Claims 8 and 26 recite a “network access manager” and “network access module,” elements that the parties construe together. The specification discloses two functions for the network access manager. First, it interfaces with a wider network, as shown in Figure 3. Second, the network access manager “controls time-slot allocation among the synchronous modules and the packet modules.” (Ex. 1 at 5:11-13.) While Comcast does not believe the term “network access module” needs to be construed, Rembrandt believes a construction consistent with the specification would help the jury understand both what a network access module is and what functions it performs.

C. U.S. Patent No. 4,937,819

1. Patent Overview

In TDM networks (as in most networks), information takes some amount of time to travel from one network node to another. Due to factors such as the varying distances between nodes, the transmission delay or “latency” between one remote unit and a central node can be different than the latency between a different remote unit and the central node. Ranging is a mechanism by which the network can determine latency for each remote unit.

The ’819 patent discloses an improved ranging mechanism for nodes on a TDM network that has multiple applications running over the network. According to the specification, the patented system compensates for transmission delays by “ranging or measuring the round-trip transmission or delay time between the master unit and each remote unit.” (Ex. 2 at 2:10-12.) This range is “transmitted from the master unit to the remote units,” and the remote units adjust the timing of their transmissions so that data is received at the master unit as if it were sent without delay. (*Id.* at 5:40-42.) One of the advantages of the ’819 invention is to reduce empty “guard” times between transmissions, thereby making more efficient use of the network.

Claim 1 is representative. It recites a plurality of “remote units,” each running one or more “application programs” and at least one unit running two or more application programs, where the remote units send data in time slots assigned to the application programs. (*Id.* at 7:29-36.) The claim further recites a master network timing means with a “period” that is subdivided into further time units. (*Id.* at 7:37-43.) That master unit also includes a “ranging means.” (*Id.* at 7:44-45.) The system calculates the transmission time between the master unit and remote units, and sends that time to each respective remote unit. (*Id.* at 7:46-49.) The remote units utilize this transmission time “to adjust initiation of said time slots.” (*Id.* at 7:50-51.)

2. application program[s] (claims 1, 14)

Construction: a computer program or process

The claims and specification support a broad construction of the term “application program.” It is used generically both in the claims of the ’819 patent, and throughout the specification and prosecution history. Neither the nature of the data that is sent between the master unit and the remote units, nor the nature of the application programs that generate that data, is important to the invention recited in the claims. This is confirmed by the inventor, who testified that the system was “transparent to the application.” (Ex. 23 at 58:6-7.)

Relevant telecommunications dictionaries published around the time of the patent likewise define an application program broadly, for example “a computer program that is used for a specific application,” (Ex. 10), and “a software program that carries out some useful task” (Ex. 11). Rembrandt’s construction is thus consistent with both the intrinsic record and the ordinary meaning expressed in relevant technical dictionaries published at the relevant time.

In contrast, Comcast improperly seeks to narrow the meaning of application program to specifically exclude programs that “perform management of or maintenance work on the system or system components.” The evidence on which Comcast relies includes several dictionary definitions that were published by end-user software manufacturers, like Microsoft, rather than by telecommunications providers, and that were published well after the ’819 patent issued.

These irrelevant and untimely definitions are inconsistent with the intrinsic record and should be rejected. *See Brookhill-Wilk 1, LLC. v. Intuitive Surgical, Inc.*, 334 F.3d 1294, 1299 (Fed. Cir. 2003) (disregarding dictionary definitions that were not contemporaneous with the patent filing). For example, one untimely source that Comcast relies upon even states that “[t]he definitions on Webopedia evolve and change as technologies change, so the definitions are frequently updated to reflect trends in the field.” (Ex. 12.) Another source, from a web site known as Wikipedia, is created and edited by members of the public at large rather than persons of ordinary skill in the telecommunications arts. (*See* Ex. 13.) This “evidence” comes from sources that are too general to bear on the question at hand, is not relevant to the context of these patents, and should be rejected on that basis.

3. time slot assigned to each of said application programs (claim 1)

Construction: a “time slot” is an interval of time during which data from an application program is transmitted; rest of limitation is ordinary meaning

Rembrandt’s construction of “time slot” is clear from the claim language itself, which recites that each remote unit “respond[s] in a time slot assigned to each of said application programs.” (Ex. 2 at 7:35-36.) The specification likewise states that remote units “respond in a unique time period assigned to each host application.” The remainder of this limitation is clear on its face, and needs no construction.

Comcast’s proposed construction improperly seeks to read in limitations from the specification and narrow this limitation beyond its plain and ordinary meaning. Specifically, Comcast would construe “time slot” to mean an interval of time “assigned at initialization” to each application program. Nothing in the ’819 patent supports this reading, and in fact this clear narrowing would be **inconsistent** with the patent specification and claims.

The patent states that a remote unit can request additional time slots during data transmission (which is necessarily after initialization), and a central unit can grant the request dynamically. (*Id.* at 2:18-26; 3:7-11.) Claim 2 of the patent recites a “reservation request

generator” and “reservation request processor” that allow these additional time slots to be requested and assigned. Indeed, Comcast’s expert agreed that the ’858 patent describes assigning time slots dynamically. (Ex. 7 at 186:23-187:4.) Comcast’s proposed construction would completely exclude these claimed features, and should therefore be rejected.

4. master network timing means with a period which is divided into a plurality of subframes, wherein each subframe is divided into said time slots, and each of said time slots is used as an interval in which one of said application programs in said one of said remote units is assigned to transmit (claim 1)

Construction: “master network timing means” is a clock for determining network timing or for delineating time into time slots; rest of limitation is construed according to ordinary meaning

Rembrandt’s construction of “master network timing means” is directly supported by the specification. The claim itself states that the master network timing means has a period divided into subframes, and this is precisely the description given to a specific “master network clock” in the specification: “The period of the master network clock transmission establishes a ‘frame’. This frame is further segmented into subframes at the remote.” (Ex. 2 at 6:37-39.) These subframes are in turn divided into time slots. (*Id.* at 7:38-39.) Thus the master network timing means is simply a clock that delineates time slots on the network.

Comcast incorrectly asserts that this limitation should be construed as a “means-plus-function” limitation under to 35 U.S.C. § 112, ¶ 6. The claim itself, however, establishes that it should *not* be subject to this type of construction, because it does not recite any function that is performed by the master network timing means. This failure to recite a function excludes the limitation from § 112, ¶ 6. *Rodime PLC v. Seagate Tech., Inc.*, 174 F.3d 1294, 1302 (Fed. Cir. 1999) (“a claim element that uses the word ‘means’ but recites no function corresponding to the means does not invoke § 112, ¶ 6”); *York Products v. Central Tractor Farm & Family Ctr.*, 99 F.3d 1568, 1574 (Fed. Cir. 1996) (“Without an identified function, the term ‘means’ in this claim cannot invoke 35 U.S.C. § 112, ¶ 6.”)

Comcast contends that the function performed by the master network timing means is “dividing the period into subframes, and the subframes further into time slots, and assigning a time slot to each application.” This misreads the claim, which does not recite that the master network timing means performs any of these functions. Rather, the claim recites that the master network timing means *has* a period that has been divided into subframes and timeslots. Comcast’s expert conceded that nothing in the ’819 patent suggests that the master network timing means performs this division. (Ex. 7 at 143:4-8.) In fact, the division is not performed by the master network timing means, but instead defined by a system *user*. (Ex. 2 at 4:54-55.)

The claim does not recite a function that is performed by the master network timing means, and § 112, ¶ 6 should not apply. Rembrandt’s construction should be adopted.⁴

5. ranging means communicating with said master network timing means wherein a transmission time between said master unit and each of said respective remote units is calculated and transmitted from said master unit to each of said respective remote units (claim 1)

Construction: “ranging means” is a device or process that determines a transmission time between the master unit and a remote unit; rest of limitation is construed according to ordinary meaning

This limitation should be construed according to its plain and ordinary meaning, as set forth in the ’819 patent specification. The specification expressly defines “ranging” as a “calculation of the time a signal takes to go from the master unit to any remote unit and vice versa.” (Ex. 2 at 3:66-68.) Rembrandt’s proposed construction follows directly from this description.

Comcast again seeks to apply 35 U.S.C. § 112, ¶ 6, but this effort is again improper. Although it uses the word “means,” the limitation fails to recite any function performed by the ranging means. Instead, all functions recited in the limitation are linked to the master unit: “a transmission time . . . is calculated and transmitted *from said master unit*”. (*Id.* at 7:46-49.) The

⁴ Should the court agree with Comcast that this limitation is governed by 35 U.S.C. § 112, ¶ 6, Rembrandt would construe the function to be generating a master network timing signal, and the corresponding structure to be the Network Timing Control Processor 12 shown in figures 1 and 3 and described at 2:60-3:6, 5:15-24 and 6:32-42. (*See* Declaration of Dr. V. Thomas Rhyne (“Rhyne Decl.”) at ¶ 13.

'819 specification is again consistent with this reading, tying these same functions to the master unit rather than the ranging means: "The master unit periodically transmits a network clock reading . . . and performs a roundtrip delay transmission calculation ('ranging') to each remote unit. The master unit informs each remote unit of its precise round trip value." (*Id.* at 6:32-36.) Even Comcast's expert testified that part of the recited function (transmission from the master unit) could be performed by components other than the "ranging means." (Ex. 7 at 160:4-18.)

Because the limitation fails to link the "ranging means" to a function, the "ranging means" should *not* be construed pursuant to § 112, ¶ 6. *See Rodime*, 174 F.3d at 1302; *York Products*, 99 F.3d at 1574. Instead, the "ranging means" should be construed to mean a device or process that determines the transmission time between the master unit and a remote unit.⁵

6. reservation request generator (claim 2)

Construction: a device or process that adds to a message a request for additional time slots

Rembrandt's construction of this term is drawn directly from the '819 patent specification. The specification states that a remote unit may add a request for additional time onto an existing message to the master unit. (Ex. 2 at 2:18-22.) The reservation request generator is the element that makes such an additional request by setting "reservation bits" within the message. (*Id.* at 4:8-14; *also see id.* at 6:67-7:2.) While Comcast does not believe this limitation needs to be construed, Rembrandt's construction clarifies the meaning of this term consistent with the patent specification. The reservation request generator allows a remote unit to request additional time slots, by adding a request to an existing data transmission, during a time slot already granted to the remote unit.

⁵ Should the court agree with Comcast that this limitation is governed by 35 U.S.C. § 112, ¶ 6, Rembrandt would construe the function to be ranging or determining the transit time between the master unit and a remote unit, and the corresponding structure to be the Network Timing Control Processor 12, Ranging and Network Initialization Generator 20, and Ranging Receiver 32 shown in figures 1 and 3 and described at 1:63-2:17, 2:57-3:6, 3:25-29, 3:42-49, 4:62-5:3, 5:24-34 and 6:32-36. (*See Rhyne Decl.* at ¶ 14.)

7. reservation request processor (claim 2)

Construction: a device or process for receiving and processing requests for additional time slots from a reservation request generator

Rembrandt's construction of this term is likewise drawn directly from the claims and specification. Claim 2 recites that the reservation request processor is "responsive to said reservation request bit." The specification is consistent with this function: "Reservation request processor 14 allows a drop or remote unit to request more than a single time slot for longer messages. Reservation request processor 14 communicates such a granted request to the network timing and control processor 12." (*Id.* at 3:7-11.) Rembrandt's proposed construction is again consistent with the claims and specification, and should be adopted here.

8. priority bit (claim 11)

Construction: one or more communication bits that are used to convey the relative importance of the communication

The plain and ordinary meaning of a priority bit is a bit of data that is used to convey the importance of a communication. For example, the relevant IEEE Dictionary defines priority to be "[t]he level of importance assigned to an item." (Ex. 14.) Similarly, Newton's Telecom Dictionary defines priority to be "[a] ranking given to a task which determines when it will be processed." (Ex. 15.)

Comcast's proposed construction is "[a] bit that defines the importance of a given remote unit relative to other remote units." This construction narrows the plain and ordinary meaning of the term "priority bit" by reading limitations from the specification into the claims. It is therefore improper. *Phillips*, 415 F.3d at 1323 (warning against reading limitations from the specification into the claims). Nothing in the claim limits the term "priority bit" to a bit that specifically defines the relative importance of remote units, as opposed to the application programs that run on the remote units. Indeed, Figure 5 of the patent shows that messages from each application contain "priority bits," and Comcast's expert testified that the priority could be assigned on an application by application basis. (Ex. 7 at 192:6-12; 195:4-17.)

- 9. dividing a period of a clock in said master unit into a number of subframes, dividing each subframe into a number of slots, each corresponding to transmission times for one of said remote units, and assigning a slot to each of said application programs (claim 14)**

Construction: ordinary meaning

This phrase needs no construction as its plain and ordinary meaning is clear. The master unit includes a clock having a temporal period that is divided into smaller amounts of time or subframes. The subframes, in turn, are further divided into time slots, and the application programs that run on the remote units are assigned to transmit data within the time slots.

Comcast improperly seeks to narrow this phrase by reading extraneous limitations from the specification into the claims. For example, Comcast seeks to construe a “subframe” as a time when only a single remote unit can transmit, and further seeks to limit the assignment of time slots to the initialization of the modem. This construction is clearly incorrect since it would read out the preferred embodiment. *See Vitronics*, 90 F.3d at 1583 (explaining that a construction that reads out a preferred embodiment “is rarely, if ever, correct and would require highly persuasive evidentiary support”). As set forth above in Section II.C.3, remote units can request additional time to transmit data. (Ex. 2 at 2:18-26.) If the request is granted, the remote unit utilizes time slots (and therefore part of a subframe) previously assigned to another remote unit at initialization. (*Id.* at 6:66-7:14.) Thus contrary to Comcast’s construction, more than one remote unit can transmit data in a subframe, and time slots can be assigned after initialization. Comcast’s attempt to read out this preferred embodiment should be rejected. *See Vitronics*, 90 F.3d at 1583.

- 10. means for calculating clock drifts of the remote units and issuing reset commands to correct the same (claim 12)**

Construction: network timing control processor 12, configured with software to determine a drift time between the master clock and a remote clock, and to issue one or more commands to correct the drift time

The parties agree that this limitation should be construed pursuant to 35 U.S.C. § 112, ¶ 6. The function to be performed by the recited means is “calculating clock drifts of the remote units and issuing reset commands to correct the same.”

Comcast asserts that the function has no corresponding structure, but this is incorrect. The specification expressly describes that “[n]etwork timing and control processor 12 uses firmware or software to implement clock drift reset functions.” (Ex. 2 at 2:61-63.) It further states that the “master unit can recognize whether a remote clock is drifting and so inform the remote” by comparing a remote unit message’s “actual time of arrival . . . with the expected time of arrival at the master unit.” (*Id.* at 7:15-20.) The network timing and control processor 12, and the algorithm run on that processor, have been identified by Rembrandt’s expert as performing the clock drift calculation function. (*See* Rhyne Decl. at ¶ 15.) Rembrandt’s proposed construction is consistent with the structure and function set forth in the specification, and should be adopted.

D. U.S. Patent No. 5,852,631

1. Patent Overview

The ’631 patent describes and claims a system to reduce the time required for two modems to establish communication with one another. In particular, the ’631 patent deals with the establishment of the two lowest “layers” of communication protocols, referred to as the “physical layer” and the “link layer,” in a taxonomy known as the Open Systems Interconnect (“OSI”) Reference Model. The OSI model and the concept of multiple layers were first formalized in a paper by Hubert Zimmerman, published by the IEEE in 1980. (Ex. 16.) Because different modems may support different protocols, it is necessary for the two modems to “negotiate” which protocols they will use.

Prior to the invention of the ’631 patent, two modems that needed to negotiate communication protocols would first negotiate the protocols needed to establish a physical layer connection, and then would negotiate to establish a link layer connection (one layer “up” from the physical layer). What the ’631 patent inventors realized was that in many cases two full negotiations were not necessary. In particular, if the physical layer negotiation revealed that both modems supported a particular physical layer modulation, the link layer negotiations could be dispensed with. (Ex. 3 at 11:44-46.)

In the described embodiment of the '631 patent, a calling modem initiates a communication session by calling an answering modem. The two modems then negotiate a physical layer connection by agreeing upon a common supported protocol (or "modulation"). (See Ex. 3 at FIGS. 4-7.) After the physical layer protocol is negotiated and established, both modems use the knowledge of the negotiated physical layer to select the link layer parameters, rather than engaging in a further link-layer negotiation. (See *id.* at 12:55-61.)

Claim 1 of the '631 patent is exemplary. It begins with a preamble that describes it as a method for establishing a link layer connection between two modems, both of which support multiple physical layer and link layer protocols. (*Id.* at 14:25-31.) The first step of the method is to establish a physical layer connection by negotiating a physical layer modulation (i.e., protocol) from among the multiple supported modulations. (*Id.* at 14:32-37.) The second step of the method is to then establish the link layer protocol based on what physical layer protocol was agreed upon by the modems. (*Id.* at 14:38-39.)

2. physical layer (claims 1, 4, 5, 6, 9, and 10)

Construction: The lowest layer of the Open Systems Interconnect (OSI) seven layer model, concerned with establishing the mechanical, electrical, functional, and procedural characteristics of a connection between two modems.

Rembrandt's construction of the term "physical layer" is drawn directly from the definition propounded in the article setting forth the OSI Reference Model, specifically referenced in the patent specification. (See Ex. 3 at 1:49.) This original and authoritative definition states that the physical layer "provides the mechanical, electrical, functional, and procedural characteristics to establish, maintain, and release physical connections." (Ex. 16 at 430.) Similarly, the IEEE Dictionary published near the time of the invention defines "physical layer" as "the layer of the ISO Reference Model⁶ that provides the mechanical, electrical, functional, and procedural characteristics [to] access . . . the transmission medium." (Ex. 17.)

⁶ The ISO Reference Model is another name for the OSI Reference Model.

Comcast's construction seeks to limit the physical layer in a manner unsupported by the evidence. Under Comcast's proposal, the physical layer is solely concerned with the "electrical and mechanical" connection between the two modems, a construction that could be satisfied by two modems connected by a wire carrying an electrical current, regardless of whether they could send data back and forth. Comcast's construction purports to draw support from a section of the specification in which the patentee listed these functions as *exemplary* aspects of the physical layer. Nowhere does the patent suggest that this was intended as a complete definition of that layer. Indeed, Comcast's own expert conceded that the physical layer is not limited to "electrical and mechanical" aspects, but rather also includes "functional and procedural" characteristics, as Rembrandt contends. (Ex. 8 at 101:11-24.)

By explicitly referencing the OSI Reference Model, the '631 patent clearly signaled that it was utilizing the term "physical layer" as it was defined in that model, encompassing mechanical and electrical as well as functional and procedural characteristics of connections between two modems, so long as those connections occur at the lowest layer of communication.

3. physical layer modulation (claims 1, 4, 5, 6, 9, and 10)

Construction: A protocol that is concerned with establishing the mechanical, electrical, functional, and procedural characteristics of a connection between two modems

The '631 patent is unambiguous that a "modulation" is simply a protocol, such as a communication standard. For example, the '631 patent explicitly refers to protocols such as V.34, V.32bis, V.32, and V.22bis as "modulations" in one paragraph (Ex. 3 at 6:15-17), and as "standard[s] or protocol[s]" in the very next paragraph (Ex. 3 at 6:35-36). Similarly, dependent claims 2 and 7 make clear that a "fast connect modem modulation" is a "physical layer modulation" (Ex. 3 at 14:40-41 & 14:64-64), while the specification refers to "fast connect" as a "protocol" (*e.g.*, Ex. 3 at 2:33-34). Since a modulation is simply a protocol, it follows that a "physical layer modulation" is a "protocol that is concerned with establishing the mechanical, electrical, functional, and procedural characteristics of a connection between two modems."

Comcast's proposed construction seeks to insert additional limitations that have no foundation in the intrinsic record. Comcast argues that a physical layer modulation is the "process or protocol that defines how bits are translated into waveforms and transmitted at the physical layer." The '631 patent, however, does not discuss translating bits into waveforms. Indeed, the "fast connect" modulation has nothing to do with translating bits into waveforms, but rather is simply a protocol that "provide[s] for faster and more efficient startup operation." (Ex. 3 at 2:29-31.)

In support of its position, Comcast cites extrinsic evidence including one dictionary definition from 2002, well after the 1997 filing of the patent-in-suit. Comcast's evidence includes no treatises or dictionaries relating specifically to modem technologies. Most significantly, Comcast's extrinsic evidence is inconsistent with the patent's disclosure. Therefore, Comcast's construction should be rejected. *See Vitronics*, 90 F.3d at 1584 (holding that extrinsic evidence may not be used to contradict the specification).

4. negotiated physical layer modulation (claims 1, 2, 4, 5, 6, 7, 9, and 10)

Construction: A physical layer modulation selected by a process permitting two modems supporting different physical layer modulations to agree on a common supported physical layer modulation

The intrinsic record explicitly defines what is meant by the term "negotiated." During prosecution, the applicant stated that "[b]y **choosing a physical layer modulation based on the capabilities of the two modems as determined at run time**, the two modems '*negotiate*' an appropriate physical layer modulation scheme." (Ex. 18 at 6.) The applicant distinguished prior art cited by the examiner by noting that the cited art "teaches that each computer should have a modem with 'a fast modem connect protocol.' . . . This teaches away from the present invention which allows modems with different connection speeds to **establish a mutually acceptable protocol**." (Ex. 18 at 7.) Thus, according to the applicant, a "negotiated" physical layer modulation is one selected by a process that allows modems with different capabilities to arrive at a mutually acceptable protocol.

Rembrandt's proposed construction is also supported by the claims themselves. The '631 patent claims recite that the calling modem have a "plurality of possible first physical layer modulations," and that the answering modem have "a plurality of possible second physical layer modulations." (*E.g.*, Ex. 3 at 14:26-28.) The physical layer connection that is established is "based on a negotiated physical layer modulation chosen from said first and second physical layer modulations." (*E.g.*, Ex. 3 at 14:34-36.) Thus, the claims recognize that the calling and answering modems may support different physical layer modulations, and the purpose of the negotiation is to choose a modulation that the modems have in common.

Comcast, again relying on extrinsic evidence, seeks to read out of the claim any requirement for actual negotiation. In Comcast's view, there is no requirement that the negotiation allow modems supporting different protocols to agree on a common supported protocol. This feature, however, is the central concept upon which the applicant relied to distinguish the prior art during prosecution, and even Comcast's expert acknowledged that the claimed negotiation entailed "permitting two modems supporting different physical layer modulations to agree on a physical layer modulation." (Ex. 8 at 181:2-12.)

Rembrandt's construction is supported by the claims, specification and prosecution history, whereas Comcast's construction is contradicted by its own expert. Rembrandt's construction should be adopted.

5. link layer (claims 1, 3, 4, 5, 6, 8, 9, and 10)

Construction: The second lowest layer of the Open Systems Interconnect (OSI) seven layer model, providing the functional and procedural means to transfer data between modems, and to detect and correct errors that can occur in the physical layer

The IEEE Dictionary (published the same year as the patent's effective filing date) defines "link layer" as the "layer of the ISO reference model that provides the functional and procedural means to transfer data between stations [*i.e.*, modems], and to detect and correct errors that can occur in the physical layer." (Ex. 19.) Rembrandt proposes that the Court adopt this definition, substituting "modems" instead of "stations" for clarity.

The patent specification is fully consistent with this definition. The patent is explicit that the link layer is where error correction takes place. For example, dependent claims 3 and 8 explicitly state that “said link layer connection is an error-correcting protocol.” (Ex. 3 at 14:42-43 & 14:66-67.) In the described embodiment of the ’631 patent, a link layer protocol called V.42 “is intended for use in establishing the error correcting protocol of the data link layer connection.” (Ex. 3 at 2:41-43.)

Comcast seeks to depart from this well accepted usage of “link layer” by reading in unnecessary limitations. Specifically, Comcast contends that the error correction in the link layer may only be of a particular kind, namely error correction that is achieved “through frame retransmission.”

Comcast’s proposed limitation is unwarranted. While correction of physical layer errors is one function that is provided by the link layer, nothing in the ’631 patent requires that “frame retransmission” be the exclusive means by which it is achieved. As noted above, the patent specifically refers to the OSI seven-layer model, and nothing in that model – or in the IEEE definition – requires error correction through “frame retransmission.”

Moreover, the extrinsic evidence supports Rembrandt’s position that error-correction in the link layer may be accomplished through means other than frame retransmission, such as through the use of error correction codes. For example, an article presented at a conference in September, 1997, proposed a “scheme *which uses a block FEC code in the data link layer* for correcting bit errors of the received packets.” (Ex. 20 at 205.) As Comcast’s expert testified, an FEC (forward error correction) code can itself detect and correct errors occurring in the physical layer – without relying on frame retransmission. (*See* Ex. 8 at 133:16-19 and 144:6-12.)

Similarly, the work of Comcast’s own expert shows that detection and correction of errors that can occur in the physical layer can be achieved in the link layer using “Reed-Solomon decoding” – a type of error correction code. (Ex. 8 at 77:5-10; 111:12-112:4; 113:12-14; 133:16-19.) This evidence belies Comcast’s contention that error correction in the link layer must occur

“through frame retransmission.” Comcast’s attempt to import a requirement that error correction be accomplished through frame retransmission should be rejected.

6. The Structure Corresponding to the Means Plus Function Terms Should Be Limited to that Structure that Is Necessary to Perform the Recited Function

Claims 6 and 9 include means-plus-function terms. Rembrandt’s designation of the structure corresponding to the recited function is limited to what is necessary to perform the corresponding function. *See Default Proof Credit Card Sys., Inc. v. Home Depot U.S.A., Inc.*, 412 F.3d 1291, 1298 (Fed. Cir. 2005). In contrast, Comcast seeks to incorporate large swaths of portions of the patent disclosure that even Comcast’s expert admits are unnecessary. (*See* Ex. 8 at 227:10-19; 228:7-15; 234:20-235:10; 237:8-16; 238:23-239:2; 239:19-240:7.)

The ’631 patent discloses programmable hardware such as a microprocessor (specifically, a control processor or a digital signal processor chip (*see* Ex. 3 at 6:10-11)), configured to execute algorithms corresponding to the functions recited in claims 6 and 9. (*See* Rhyne Decl. at ¶¶ 10-12.) Thus, the structure corresponding to each of the means-plus-function terms is programmable hardware configured to execute the identified algorithm. *See WMS Gaming, Inc. v. Int’l Game Tech.*, 184 F.3d 1339, 1348 (Fed. Cir. 1999).

The function of the first term is “establishing a physical layer connection based on a negotiated physical layer modulation.” (*See* Joint Claim Construction Statement at A-13.) The structure necessary to perform this function is programmable hardware configured to execute the algorithm set forth in those aspects of the patent’s Figures 4-7 that are highlighted in the attached Exhibits 5-A through 5-D, or equivalent structures. (*See* Rhyne Decl. at ¶ 10.)

The function of the second term is “establishing the link layer connection based upon the negotiated physical layer modulation.” (*See* Joint Claim Construction Statement at A-15.) The only structure necessary to perform this function is programmable hardware configured to “establish[] a link layer connection substantially instantaneously upon the completion of the physical layer negotiation,” or equivalent structures. (*See* Ex. 3 at 11:44-46; Rhyne Decl. at ¶ 11.)

Finally, the function of the third term is “presetting link layer parameters based on the negotiated physical layer modulation.” (*See* Joint Claim Construction Statement at A-16.) The only structure needed to perform this function is identified clearly in the specification: programmable hardware configured to “[p]reset[] the XID phase parameters to default values that are based upon the negotiated physical layer connection,” and equivalent structures. (*See* Ex. 3 at 12:59-61; Rhyme Decl. at ¶ 12.)

E. U.S. Patent No. 5,243,627

1. Patent Overview

The '627 patent generally relates to the field of error correction in digital transmission systems. In such systems, a sequence of digital data is transmitted from a transmitter to a receiver, typically by modulating an analog waveform using the digital data. (*See* Ex. 4 at 4:62-64.) When the analog waveform is received at the receiver, it must be demodulated to recover the transmitted digital data. (Ex. 4 at 4:48-66.)

A basic problem in the design of such data transmission systems is how to eliminate the effect of “noise” introduced into the data signal during transmission. (Ex. 4 at 1:29-33.) This noise, which may result for example from environmental factors or imperfections in the transmission equipment, can modify the transmitted signal so that the analog signal received by the receiver is different from what was transmitted by the transmitter. Such noise can “worsen the effectiveness of the . . . receiver to recover the transmitted data.” (Ex. 4 at 1:29-33.)

Digital data transmission systems typically include some type of error correction coding to aid in the recovery of the transmitted signal. (Ex. 21 at 1:23-37.) These error correction codes aim to mitigate the problems caused by noise. (Ex. 21 at 1:23-37.) In one technique, the transmitter includes a so-called “trellis encoder” to encode data while the receiver includes a corresponding trellis or “Viterbi” decoder to decode data. (Ex. 21 at 2:44-45 and 3:21-29.)

The trellis encoder adds “redundant bits . . . systematically to the data bits” to be sent before modulation. (Ex. 21 at 1:37-41.) There is an “inherent correlation between these redundant bits,” which is used to help the receiver recover transmitted data that is lost because of

noise. (Ex. 21 at 1:41-43.) Because the trellis encoder allows “only predetermined transitions from one sequential group of bits . . . to another,” the Viterbi decoder is able to determine from a received sequence of bits whether that sequence is erroneous – i.e., whether it fails to follow the prescribed pattern of transitions – and if so, to estimate the most likely sequence that was actually transmitted. (Ex. 21 at 1:37-41.)

While useful, Viterbi decoders can fail to properly correct errors under certain conditions. In particular, Viterbi decoders can fail to correct data streams affected by “relatively long error signals,” i.e., bursts of noise that affect a sequence of transmitted data over an extended period of time. (Ex. 21 at 1:46-50.) Such error signals – referred to in the ’627 patent as “correlated noise” – “inhibit[] the correction of received bits” using Viterbi decoders because too many successive received data values are erroneous. (Ex. 4 at 1:38-44; Ex. 21 at 1:46-52.) The closest valid sequence as determined by the Viterbi decoder may not be the sequence that was actually transmitted.

The ’627 patent, which was issued to William Betts and Edward Zuranski, teaches a novel mechanism, called “signal point interleaving,” for reducing the vulnerability of Viterbi decoders to correlated noise. As the ’627 patent explains, this mechanism represents an improvement over an earlier technique called “channel symbol interleaving” that was disclosed by Mr. Betts and others in prior art U.S. Patent 4,677,625 (“the ’625 patent”). (Ex. 4 at 1:33-2:2.)

The earlier channel symbol interleaving technique entailed using multiple trellis encoders in a single transmitter, and multiple corresponding Viterbi decoders in the corresponding receiver, to improve the correction of errors caused by correlated noise. (Ex. 4 at 34-38; Ex. 21 at 1:56-59.) In the preferred embodiment of the ’625 patent, the transmitter comprised a “distributed trellis encoder” having four distinct trellis encoder elements, as shown in Figure 1 of the ’625 patent, reproduced (with color highlighting added) in Exhibit 6A.

To accomplish channel symbol interleaving, data was sent to the individual trellis encoders in “round-robin fashion,” meaning the trellis encoders take turns operating on data.

(Ex. 4 at 1:59-62.) Accordingly, only the currently “active” trellis encoder would encode data, while the “other . . . trellis encoders are idle.” (Ex. 21 at 2:50-52.) The receiver in the ’625 patent would use a corresponding distributed Viterbi decoder to decode the received data (Ex. 4 at 1:62-65; Ex. 21 at 2:2-4, 3:67-4:3), as can be seen in Fig. 3, reproduced with added color highlighting in Exhibit 6-B. Like the distributed trellis encoders, the distributed Viterbi decoders operated in a round-robin fashion, so that only one Viterbi decoder was active at a time. (Ex. 21 at 3:43-49.) As a result, each Viterbi decoder in the receiver only decoded that data that was generated by a corresponding trellis encoder in the transmitter. (*See* Ex. 21 at 3:47-55.)

The advantage of using multiple, corresponding pairs of round-robin activated trellis encoders and Viterbi decoders, as opposed to a single conventional trellis encoder / Viterbi decoder pair, lay in the resulting “*interleaving*” of data transmitted between the respective pairs of encoders and decoders. (Ex. 4 at 1:59-2:2.) In particular, the round-robin mechanism caused “channel symbols” from a given trellis encoder – values representing successive chunks of data processed by the trellis encoder – to be separated from each other on the transmission channel. (Ex. 4 at 1:59-2:2.) The figure in Exhibit 6-C illustrates the resulting pattern of channel symbols on the transmission channel, with each color representing channel symbols that are encoded and decoded by respective trellis encoder/decoder pairs.

As can be seen from this pattern, no two channel symbols associated with a given trellis encoder/decoder pair are adjacent to each other on the transmission channel. (*See* Ex. 4 at 1:59-2:2.) As a result, correlated noise would have to last longer to affect enough channel symbols from any given trellis encoder to prevent their accurate reception by the corresponding Viterbi decoder.. (*See* Ex. 4 at 1:49-52.) For example, consider a burst of noise that impairs the values of four consecutive channel symbols in the stream above. If all the channel symbols were to be processed by a single trellis encoder/decoder pair, the Viterbi decoder would have to correct four successive erroneous values, possibly overwhelming its ability to recover the original data stream. (*See* Ex. 21 at 1:41-52.) However, when the noise impacts channel symbols from four separate trellis encoder/Viterbi decoder pairs operating in a round-robin fashion, each Viterbi

decoder would only need to decode one of the four erroneous channel symbols, thereby reducing the likelihood that any given Viterbi decoder would fail to make the proper error correction.

(See Ex. 4 at 3:61-64.)

The improvement of the '627 patent comprises augmenting the channel symbol interleaving technique disclosed in the '625 patent with an additional technique called "signal point interleaving." (Ex. 4 at 2:12-14.) Whereas the channel symbol interleaving of the '625 patent provides a way of reducing the amount of correlated noise seen in *successive channel symbols* transmitted between a given trellis encoder/Viterbi decoder pair, the addition of signal point interleaving takes this concept one step further by reducing the amount of correlated noise *within a single channel symbol*. (Ex. 4 at 2:5-14.)

As in the '625 patent, the transmitter of the '627 patent features a "distributed trellis encoder" comprising, in the preferred embodiment, three trellis encoder "stages" that operate in a round-robin fashion. (Ex. 4 at 4:64-5:5.) The preferred transmitter of the '627 patent, illustrated in Figure 3, is reproduced (with color highlighting added) in Exhibit 6-D. Three trellis encoder stages, 319 α , 319 β and 319 γ , perform channel symbol interleaving in a manner essentially the same as that taught in the '625 patent (Ex. 4 at 5:1-5): successive channel symbols generated using a given trellis encoder stage are separated from one another by other channel symbols generated using the other two trellis encoder stages. As in the '625 patent, this reduces the likelihood of correlated noise affecting successive channel symbols to be decoded by the same Viterbi decoder stage.

The '627 patent then provides an additional technique – signal point interleaving – that reduces the amount of correlated noise within a single channel symbol. (See Ex. 4 at 2:5-14.) Reducing correlated noise within a single channel symbol is advantageous in coding systems where larger amounts of data are allocated to each trellis encoder every time a trellis encoder is active. (See Ex. 4 at 2:5-14 and 2:61-3:3.) Larger inputs fed into each active trellis encoder produce larger trellis encoded channel symbol outputs. (Ex. 4 at 3:52-4:3.) These larger channel symbol outputs often need to be sent in more than one signaling interval.

For example, the trellis encoded channel symbol shown in Exhibit 5-D is too large to be modulated by the transmitter in one “signaling interval” – a unit of time corresponding to how much digital data can be represented at once on an analog waveform to be transmitted to the receiver. (Ex. 4 at 2:21-28; Ex. 4 at 3:38-42.) Instead, it is composed of multiple “signal points,” each of which can be modulated during a single signaling interval. (Ex. 4 at 3:38-42; & 3:52-4:3.) In the diagram shown in Exhibit 6-E, therefore, it takes two signaling intervals to modulate and transmit the trellis encoded channel symbol from the transmitter to the receiver, with one signal point being modulated and transmitted during each signaling interval. (See Ex. 4 at 3:38-42.)

What the inventors of the '627 patent discovered was that in data transmission systems where multiple trellis encoders encoded channel symbols comprised of multiple signal points, the signal points of any single channel symbol remained vulnerable to correlated noise because they remain adjacent to one another. (Ex. 4 at 2:5-13). To solve this problem, the inventors of the '627 patent developed a signal point interleaving technique that requires “the constituent signal points of the channel symbols to be non-adjacent as they traverse the channel.” (Ex. 4 at 2:5-13.)

The effect of this further optimization on the transmission pattern of signal points can be seen in two sequences found in Exhibit 6-F, which are taken from Figure 5 of the '627 patent (with color highlighting added). Both sequences show the signal points that make up the channel symbols generated using respective trellis encoder stages 319α , 319β , and 319γ . In the first sequence, only the invention of the '625 patent is used. As a result, while the channel symbols generated by the different trellis encoders are spaced apart from each other (e.g., channel symbol $[x_0^{\alpha}x_1^{\alpha}]$ is spaced apart from channel symbol $[x_6^{\alpha}x_7^{\alpha}]$), the component signal points of each channel symbol remain adjacent to each other. (See Ex. 4 at 6:62-7:6.) “[S]ince all the signal points of a channel symbols must be processed serially by the same Viterbi decoder stage, this means that the Viterbi decoder must process adjacent signal points that have highly correlated noise components.” (Ex. 4 at 7:1-6.)

By contrast, in the second sequence, which was generated using the invention of the '627 patent, there is a separation of at least three signaling intervals between a) the signal points which belong to any particular channel symbol, and b) the signal points which belong to successive channel symbols output by a given trellis encoder. (Ex. 4 at 7:58-64.) This combination of signal point interleaving and channel symbol interleaving reduces the effect of correlated noise during transmission and improves the ability of the Viterbi decoder stages to correctly receive the transmitted signal. (Ex. 4 at 7:55-8:2.)

2. Exemplary Claim: Claim 9 of the '627 Patent

Claim 9 (Ex. 4 at 11:12-35) provides an example of the claims at issue in this case. The claim begins by asserting that it is directed to the receiver of a data transmission system that receives a stream of "trellis encoded signal points":

Receiver apparatus for recovering information from a received stream of trellis encoded signal points,

The claim then shifts focus to the transmitter, describing how that stream of signal points is created in the transmitter. Consistent with the patent's teaching of multiple trellis encoders, the claim indicates that these signal points must be generated as part of two or more "streams" of trellis encoded channel symbols:

said signal points having been transmitted to said receiver apparatus by transmitter apparatus which generates said signal points by generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said information,

The trellis encoded channel symbols each have multiple signal points:

each of said channel symbols being comprised of a plurality of signal points,

There is an interleaving process that takes place to form the stream of signal points to be transmitted:

and by interleaving the signal points of said generated channel symbols to form said stream of trellis encoded signal points,

As discussed above, the required interleaving involves separating the data in two ways. First, the interleaving must separate the signal points within a given channel symbol, i.e., they must be “non-adjacent”:

said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points

Second, the interleaving must separate the channel symbols emanating from each trellis encoder stage (or more precisely their component signal points):

and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points,

The focus then returns to the receiver:

said receiver apparatus comprising

The receiver includes a way to reverse the interleaving process that took place in the transmitter:

means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols, and

The receiver also includes a Viterbi decoder with multiple stages to recover the information transferred via the signal points:

a distributed Viterbi decoder for recovering said information from the deinterleaved signal points.

3. trellis encoded channel symbol (claims 9, 19)

Construction: a set of one or more trellis encoded signal points that corresponds to a group of bits that is treated as a unit by an encoding system

Rembrandt’s construction of the term “trellis encoded channel symbol” is fully consistent with and supported by the intrinsic record. The patent specification, the “single best guide to the meaning of a disputed term,” *Phillips*, 415 F.3d at 1315, specifically describes how to identify a trellis encoded channel symbol.

Serial-to-parallel converter 115 . . . provides, during each succession of symbol intervals, some predetermined number of parallel bits on lead 109 and some number of parallel bits on lead 108 . . . [T]he words on lead 109 are used by trellis encoder 119a to sequentially identify on lead 121N [sic “121 N”] subsets, while

the words on lead 108 are used to generate N corresponding index values on lead 117. The N signal points *identified in this way* are the component signal points of a 2N-dimensional [trellis encoded] channel symbol.

(Ex. 4 at 2:61-65 and 3:53-58.) Thus, according to the '627 patent, a channel symbol is the output of the trellis encoding process corresponding to a group of input bits – the “parallel bits” – that are grouped together and presented to the trellis encoding mechanism. This group of bits is used to form, and thus corresponds to, the trellis encoded channel symbol generated by the trellis encoding mechanism. Comcast’s expert agreed that a trellis encoded channel symbol is a function of these parallel bits. (Ex. 8 at 273:3-8.) Thus, Rembrandt’s construction reflects this explicit teaching of the '627 patent.

Comcast’s construction, on the other hand, limits trellis encoded channel symbols to outputs derived from a “single state transition” of the trellis encoder. Such a limitation is not supported, and in fact is directly contradicted, by the patent specification. According to the patent, a channel symbol is derived from “a succession of N outputs from the trellis encoder.” (Ex. 4 at 4:20.) As Comcast’s expert admits, each of these multiple outputs of the trellis encoder corresponds to a separate state change. (Ex. 8 at 247:5-9.) Thus the channel symbols specifically described in the '627 patent would not satisfy Comcast’s definition, making that definition presumptively incorrect. *Primos, Inc. v. Hunters Specialties, Inc.*, 451 F.3d 841, 848 (Fed. Cir. 2006) (“[W]e also should not normally interpret a claim term to exclude a preferred embodiment.”).

4. signal point (claims 9, 19)

Construction: a value that is transmitted by a modulator in one signaling interval

The '627 patent teaches that a transmitter uses a modulator to transmit signal points to the receiver. “The signal point . . . is passed on to modulator 128 to generate a pass-band line signal which is applied to the communication channel.” (Ex. 4 at 3:38-42.) Each signal point on the communication channel corresponds to a value transmitted in one signaling interval. The signal point generated in the “nth baud [or signaling] interval” is passed to the modulator for

transmission. (Ex. 4 at 2:21-28 and 3:38-42.) This is also shown by reference to the number of signal intervals that separate signal points on the communication channel during transmission. As one of many examples, the patent specification describes signal point x_1^a in the stream of signal points $x_1^a, x_2^a, x_3^a, x_4^a, x_5^a, x_6^a$ as being separated from the signal point x_6^a by five signaling intervals, demonstrating that a signal point gets transmitted every signaling interval. (Ex. 4 at 2:21-28 and 6:58-61.)

Comcast asserts that a signal point is a point in a “signal constellation,” apparently to limit signal points to values in a two dimensional modulation scheme such as quadrature amplitude modulation (“QAM”). Such a limitation is unwarranted. QAM is merely the modulation scheme used in the preferred embodiment of the ’627 patent. As Comcast’s own expert agreed, the term signal point has a much broader meaning, and can be used to refer to values in other modulation schemes. (Ex. 8 at 248:13-16 and 248:21-249:2.) For example, the art uses “signal point” to refer to the values in a one-dimensional modulation format known as VSB:

“It should be noted that the input to an M-ary VSB modulator is a sequence of one-dimensional ($P=1$) **signal points** whereas the input into a QAM modulator is a sequence of two-dimensional ($P=2$) **signal points**.”

(U.S. Patent No. 5,706,312 (Ex. 22) at 3:10-14.) Comcast’s expert agrees that this is an acceptable usage of the term “signal point.” (Ex. 8 at 248:13-16 & 248:21-249:2).

Nothing in the ’627 patent suggests a narrower meaning for “signal point,” and Comcast’s attempt to limit the claim to the preferred embodiment should be rejected.

5. distributed Viterbi decoder (claims 9, 19)

Construction: a Viterbi decoder having multiple Viterbi decoding processes operating on separate portions of a stream of data to be decoded

Rembrandt’s construction of “distributed Viterbi decoder” gives the term its full scope supported by the patent specification. The distributed Viterbi decoder, in one embodiment, is shown as consisting of multiple separate Viterbi decoder stages. (Ex. 4 at Figure 4.) The patent

specification makes clear, however, that the distributed Viterbi decoder could be implemented in software as a decoder with a single stage that continually switches the input data to the decoder stage, making it function effectively as a decoder with multiple stages. Thus, the distributed Viterbi decoder could be implemented as a single software program that emulates the function of multiple physical devices:

“[M]ultiple trellis encoders and decoders can be realized using a single program routine which, ***through the mechanism of indirect addressing of multiple arrays within memory***, serves to provide the function of each of the multiple devices.”

(Ex. 4 at 9:61-66.) Comcast’s expert admitted that such an implementation represents an embodiment of the invention of the ’627 patent. (Ex. 8 at 254:1-255:8.)

Rembrandt’s construction allows for this kind of decoder, consistent with the patent specification, while Comcast’s construction unnecessarily limits the distributed Viterbi decoder to multiple, distinct “structures.” Because the specification clearly teaches an invention that does not require such structures, Comcast’s construction is incorrect.

6. means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols

Construction: interpreted under 35 U.S.C. §112, ¶ 6.

Function: to reverse the process of interleaving performed in the transmitter to recover multiple streams of trellis encoded channel symbols from the interleaved signal points

Structure: signal point deinterleaver 441 or switching circuit 431, or a software based deinterleaver or switching circuit, and equivalents

The first step in construing a means-plus-function claim limitation is to identify the corresponding function. *Lockheed Martin Corp. v. Space Systems/Loral, Inc.*, 324 F.3d 1308, 1318 (Fed. Cir. 2003). The essential difference between the competing “function” constructions is that Rembrandt has attempted to explain and clarify that deinterleaving is reversing the process of interleaving, while Comcast has merely repeated “deinterleaving” in its construction. Rembrandt submits that the clarification is helpful to understanding the term.

Turning next to the structure, the law is clear that §112, ¶6 does not permit incorporation of structure from the written description “beyond that necessary to perform the claimed function.” *Micro Chem., Inc. v. Great Plains Chem. Co., Inc.*, 194 F.3d 1250, 1258 (Fed. Cir. 1999). Comcast’s expert, however, admitted that Comcast’s proposed construction incorporates more structure than was necessary to perform the recited function. (*See* Ex. 8 at 255:23-256:8 & 256:25-257:4.)

If the specification identifies multiple structures that can perform the function, then any of those structures may be the corresponding structure. *Creo Prods., Inc., v. Presstek, Inc.*, 305 F.3d 1337, 1345 (Fed. Cir. 2002). The ’627 patent identifies a variety of structures that can perform the recited deinterleaving function: (1) Signal point deinterleaver 441, which deinterleaves received signal points (Ex. 4 at 5:67-6:16); (2) switching circuit 431, which performs channel symbol deinterleaving (Ex. 4 at 5:67-6:16); and (3) “an appropriately programmed processor” that performs the functions of the signal point deinterleaver or switching circuit (Ex. 4 at 9:60). Accordingly, any one of these structures may serve as the corresponding structure in the construction of this claim element.

III. CONCLUSION

For the reasons set forth above, Rembrandt’s proposed claim constructions should be adopted.

Dated: December 27, 2006

Respectfully submitted,

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CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true and correct copy of the above and foregoing document has been served on the 27th day of December to all counsel of record who are deemed to have consented to electronic service via the Court's CM/ECF system per Local Rule CV-5(a)(3). Any other counsel of record will be served by electronic mail, facsimile transmission and/or first class mail on this same date.

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**UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

REMBRANDT TECHNOLOGIES, LP

Civil Action No. 2:05-cv-00443-TJW

Plaintiff,

v.

**COMCAST CORPORATION;
COMCAST CABLE
COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP**

Defendants.

DECLARATION OF DR. V. THOMAS RHYNE

I, Dr. V. Thomas Rhyne, have been retained by Plaintiff Rembrandt Technologies, LP (“Rembrandt”) to provide expert testimony in connection with the above captioned matter. I submit this declaration in support of Rembrandt’s Claim Construction Brief.

1. I received a B.S. degree in Electrical Engineering from Mississippi State University in 1962, a Masters degree in Electrical Engineering from the University of Virginia in 1964, and a Ph.D. in Electrical Engineering from the Georgia Institute of Technology in 1967. While earning these degrees, I worked part time as an Aerospace Technologist for NASA at the Langley Research Center in Langley, VA (1962-1965), and as a Systems Engineer at the Lockheed-Georgia Research Center in Marietta, GA (1965-1967).

2. Upon completing my formal education, I was employed as a Professor of Electrical Engineering at Texas A&M University, starting as an Assistant Professor in

1967. I was promoted to full Professor of Electrical Engineering in 1974, and worked in that capacity until 1986, when I left Texas A&M to work for a microelectronics research company. During my tenure at Texas A&M, I taught many classes in electronic communications, including classes in digital communications. For example, in the mid-1970s I traveled across the country with some colleagues from Texas A&M, teaching analog and digital communications technology to members of the United States Federal Highway Department. This was at a time when communications-based traffic control systems and signals were first beginning to be extensively deployed. Throughout the 1980's, I taught various courses in digital design and computer communications at both Texas A&M and at the University of Texas at Austin. These courses generally involved instruction on the fundamental technologies that are necessary to design and build digital transmitters and receivers. Often, as part of the courses I taught at A&M I would have half the class design and build their own digital transmitter, and the other half of the class design and build a digital receiver that was capable of receiving and demodulating data sent from the transmitters. Put together, the digital transmitter or MODulator, and the digital receiver or DEModulator, made a digital MODEM.

3. During my last few years at Texas A&M (1983 until 1986), I was on a leave of absence while I worked for the Microelectronics and Computer Technology Corporation (MCC) in Austin, Texas. I worked at MCC from 1983 until 1995, serving in various engineering and management roles, including Director of its Systems Technology Laboratory, Manager of its Systems Engineering Group, Director of its ATLAS Standards Laboratory, and Vice President of Research and Development for its Information Systems Division. Much of the work I did for MCC involved the design,

development, testing and support of Computer Aided Design (CAD) systems, including the design and development of a distributed database, a natural language interface to that database, and the design and development of neural network, data mining, and other advanced software applications.

4. During my tenure at MCC, I also served as a Senior Lecturer in the Department of Electrical and Computer Engineering at the University of Texas at Austin (1984-1994) teaching computer architecture, high-speed computer arithmetic, and networking.

5. Upon leaving MCC, I worked for Motorola's Semiconductor Products Sector in Austin, Texas as a Manager of Strategic Programs (1995 until 1997). Since then, I have been a part-time engineering consultant. For a more thorough statement of my education and experience, I have attached a recent copy of my CV as Exhibit A.

6. In the context of this litigation, I have been asked by Rembrandt to identify, for each limitation that at least one party contends should be construed as a means-plus-function limitation, the function that is recited in the limitation and the corresponding structure disclosed in the specification that performs that function. More specifically, I have been asked to opine on the recited function and corresponding structure of the "means for establishing a physical layer connection" limitation, the "means for establishing said link layer connection" limitation, and the "means for setting link layer parameters limitation" of U.S. Patent No. 5,852,631 ("the '631 patent"), and the recited function and corresponding structure of the "master network timing means" limitation, the "ranging means" limitation, and the "means for calculating clock drifts" limitation of U.S. Patent No. 4,937,819 ("the '819 patent").

7. I understand that Rembrandt disputes whether two of these limitations, the “master network timing means” and “ranging means” limitations, should be construed as means-plus-function limitations. I offer no opinion on that question, which I understand to be a legal question to be decided by the Court.

8. To inform my analysis and opinion concerning the limitations identified above, I have reviewed the claims, drawings, and specifications of the ’631 and ’819 patents, as well as their file histories. I have also reviewed the First Amended Joint Claim Construction and Pre-Hearing Statement the parties filed with the Court, and the December 15, 2006 letter from Tom Brown to Matthew Werdegarr re Rembrandt’s revision to the First Amended Joint Claim Construction Statement.

9. I understand that claims are to be construed to have the meaning they would have to a person of ordinary skill in the art to which a patent pertains. I believe a such a person having sufficient knowledge to understand and place into practice the inventions disclosed in the ’631 and ’819 patents would have earned at least a bachelors degree in Electrical Engineering, and would have three or more years of relevant experience in the telecommunications industry.

10. Claim 6 of the ’631 patent contains the following limitation that the parties agree should be construed as a means-plus-function limitation: “means for establishing a physical layer connection between said calling and said answer modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations.” The parties agree that the function performed by this limitation is “establishing a physical layer connection based on a negotiated physical layer modulation.” The structure necessary to perform this function

is programmable hardware (such as a microprocessor) running the algorithm defined by the flowcharts of any one of Figures 4, 5, 6, or 7 of the '631 patent, as discussed more specifically below, or the equivalent of any of those structures. The programmable hardware can be, for example, the Digital Signal Processor (DSP) 112 or the Control Processor 114 shown in Figure 9.

In Figure 4, the algorithm corresponds to the boxes labeled "Finish dialing and send Clqck-cell signal (1500 & 1900)," "1680 Hertz," "800 Hertz," "Detect other answer signal," "Perform modem startup and training," and "Synchronize to alternative modulation standard." In Figure 5, the algorithm corresponds to the boxes labeled "Clqck signal received within two seconds," "Standard automode, send ans (2100 Hz)," "Send ANSqck (V.34 S signal)," and "Perform Modem Startup and Training." In Figure 6, the algorithm corresponds to the boxes labeled "Send Clqck-Central," "ANS detected?," "ETC1 (V.32bis training), "ANSam detected?," "V.34 startup," "ANSqck detected (1680)," "Startup under alternative standard," and "Begin ETC2 startup and training." In Figure 7, the algorithm corresponds to the boxes labeled "CI of V.34 detected," "V.34 send ANSam," "CIetc1 detected," "ETC1 mode, send 'ans,'" "Clqck-cell detected (1500 & 1900)," "Send ANSqck-PSTN," "Send ANSqck (V.34 S signal) (1680 Hz)," and "ETC2 Startup (Send S signal)."

11. Claim 6 of the '631 patent also contains the following limitation that the parties agree should be construed as a means-plus-function limitation: "means for establishing said link layer connection based upon said negotiated physical layer modulation." The parties agree that the function performed by this limitation is "establishing the link layer connection based upon the negotiated physical layer

modulation.” The structure necessary to perform this agreed upon function is programmable hardware running an algorithm that “establishe[s] a link layer connection substantially instantaneously upon the completion of the physical layer negotiation” (or equivalent structures) as described in the ‘631 specification at column 11, lines 45-46, and as depicted graphically in the connect sequence 104 shown in Figure 8, which omits the error correction negotiation step 44 shown in the connect sequence 102. The programmable hardware that performs this algorithm can again be the DSP 112 or the control processor 114 shown in Figure 9.

12. Claim 9 of the ’631 patent contains the following limitation that the parties agree should be construed as a means-plus-function limitation: “means for presetting link layer parameters of said link layer connection to pre-defined settings based on said negotiated physical layer modulation.” The parties agree that the function performed by this limitation is “presetting link layer parameters based on the negotiated physical layer modulation.” The structure necessary to perform this agreed upon function is programmable hardware running an algorithm that “preset[s] the XID phase parameters to default values that are based upon the negotiated physical layer connection” (or equivalent structures) as described in the patent specification at column 12, lines 59-61. The programmable hardware can again be the DSP 112 or the Control Processor 114 shown in Figure 9.

13. Claim 1 of the ’819 patent contains the following limitation that Comcast believes should be construed as a means-plus-function limitation: “master network timing means with a period which is divided into a plurality of subframes, wherein each subframe is divided into said time slots, and each of said time slots is used as an interval

in which one of said application programs in said one of said remote units is assigned to transmit.” I understand the parties dispute not only whether this limitation should be construed as a means-plus-function limitation, but also, what function is performed by the master network timing means should it be construed as a means-plus-function limitation. I offer no opinion on whether this limitation should be construed as a means-plus-function limitation. However, were it to be so construed, I believe the function that is performed by the master network timing means is generating a periodic, master network timing signal. The structure needed to perform this function is the Network Timing Control Processor 12 shown in Figures 1 and 3.

14. Claim 1 of the '819 patent also contains the following limitation that Comcast believes should be construed as a means-plus-function limitation: “ranging means communicating with said master network timing means wherein a transmission time between said master unit and each of said respective remote units is calculated and transmitted from said master unit to each of said respective remote units.” As with the “master network timing means,” I understand the parties dispute not only whether this limitation should be construed as a means-plus-function limitation, but also, what function is performed by the “ranging means” should it be construed as a means-plus-function limitation. I offer no opinion on whether this limitation should be construed as a means-plus-function limitation. However, were it to be so construed, I believe the function that is performed by the “ranging means” is performing ranging. By ranging, I mean determining the range or distance (as measured by the transmission time) between the master unit and each remote unit. The structure needed to perform this function is

the Ranging and Network Initialization Generator 20, the Network Timing Control Processor 12, and the Ranging Receiver 32 shown in Figures 1 and 3.

15. Claim 12 of the '819 patent also contains the following limitation that the parties agree should be construed as a means-plus-function limitation: "means for calculating clock drifts of the remote units and issuing reset commands to correct the same." I understand, however, that the parties dispute what function is performed by the "means for calculating clock drifts." I believe the function performed by the "means for calculating clock drifts" is "determining a drift time between the master clock and a remote clock and issuing one or more commands to correct the drift." The structure described in the specification that performs that function is the Network Timing Control Processor 12 shown in Figures 1 and 3, when configured to run the algorithm described in column 7 at lines 15-20.

I swear under penalty of perjury under the laws of the United States that the foregoing is true and correct.

Executed on December 27, 2006

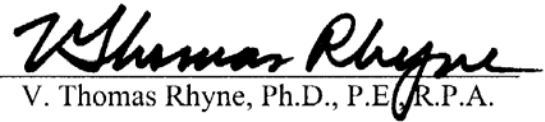

V. Thomas Rhyne, Ph.D., P.E., R.P.A.

Exhibit 1

US005719858A

United States Patent [19][11] **Patent Number:** **5,719,858****Moore**[45] **Date of Patent:** **Feb. 17, 1998**

[54] **TIME-DIVISION MULTIPLE-ACCESS
METHOD FOR PACKET TRANSMISSION ON
SHARED SYNCHRONOUS SERIAL BUSES**

[75] Inventor: **Wayne T. Moore**, Clearwater, Fla.

[73] Assignee: **Paradyne Corporation**, Largo, Fla.

[21] Appl. No.: **509,309**

[22] Filed: **Jul. 31, 1995**

[51] Int. Cl.⁶ **H04B 7/212**

[52] U.S. Cl. **370/347; 370/349; 370/442;
370/458; 370/468; 340/825.5**

[58] **Field of Search** **370/349, 331,
370/335, 355, 442, 462, 461, 460, 463,
352, 353, 468, 447, 405, 458, 347; 340/825.5**

[56] **References Cited**

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Primary Examiner—Wellington Chin

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[57] **ABSTRACT**

A plurality of packet data sources, e.g., packet application modules, and synchronous data sources, e.g., synchronous application modules, are coupled to the same TDM bus for communicating data to a network access module. A portion of the bandwidth, or time-slots, of the TDM bus is allocated as a multiple-access packet channel that is shared among the packet application modules. As a result, the network access module receives a single, continuously multiplexed, packet stream for transmission to an opposite endpoint. Packet application modules on the TDM bus contend for this multiple access packet channel when transmitting to the opposite endpoint. In the receiving direction, each packet application module accepts the entire received packet stream from the network access module and may either filter the packets using their address field or may transparently forward the data to a packet service.

32 Claims, 4 Drawing Sheets

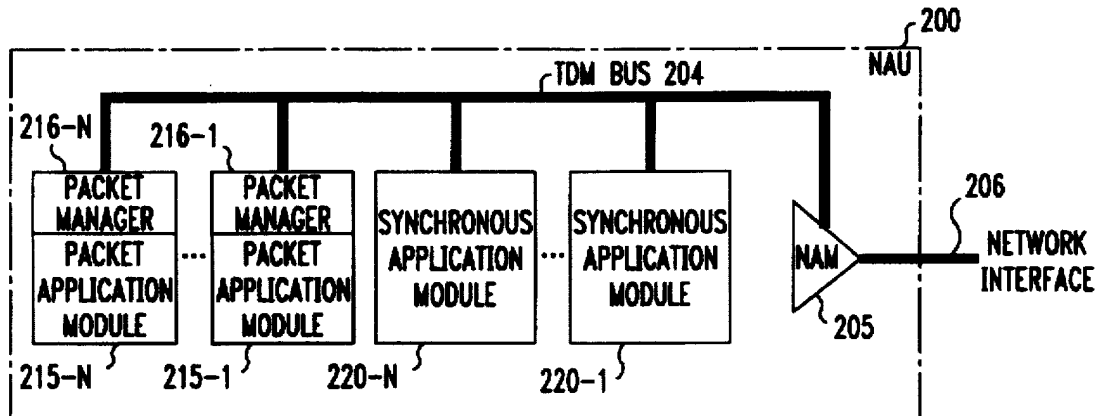


FIG. 1

PRIOR ART

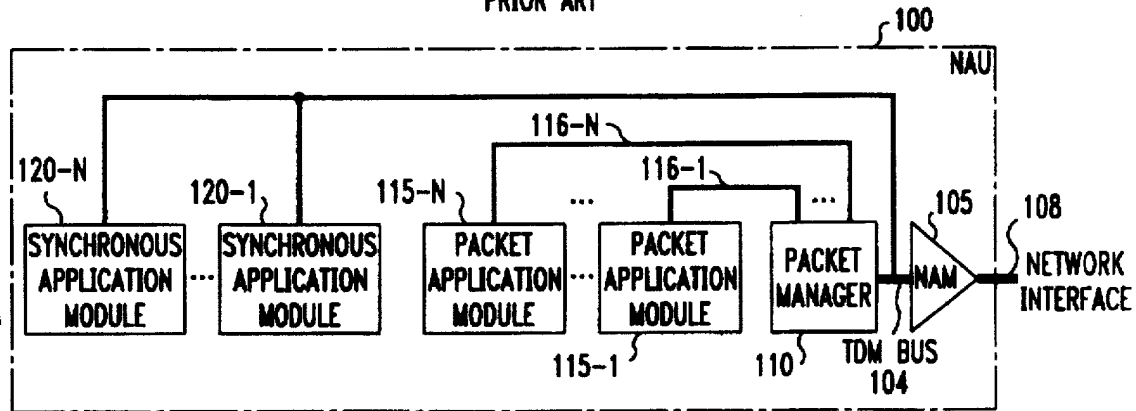


FIG. 2

PRIOR ART

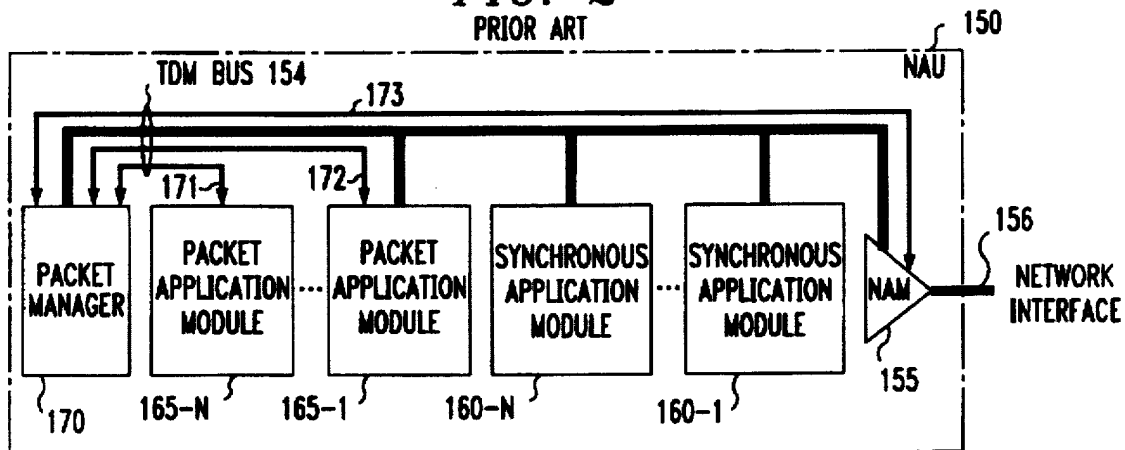


FIG. 3

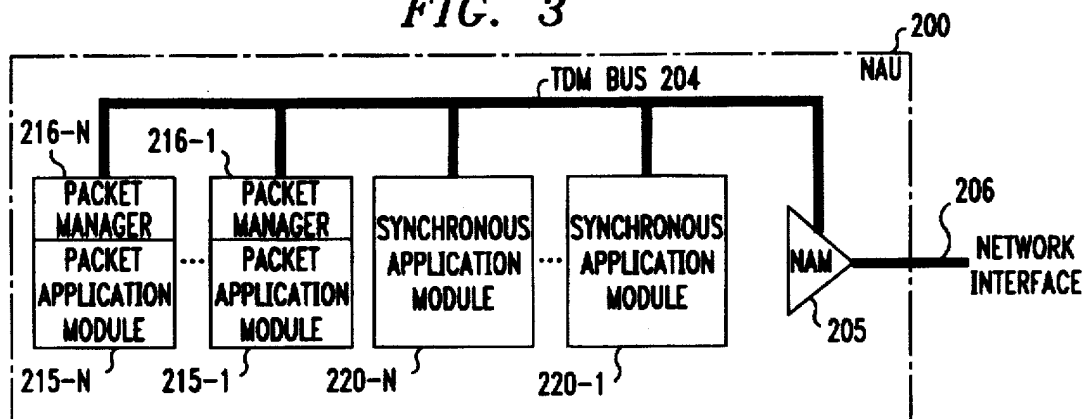


FIG. 4

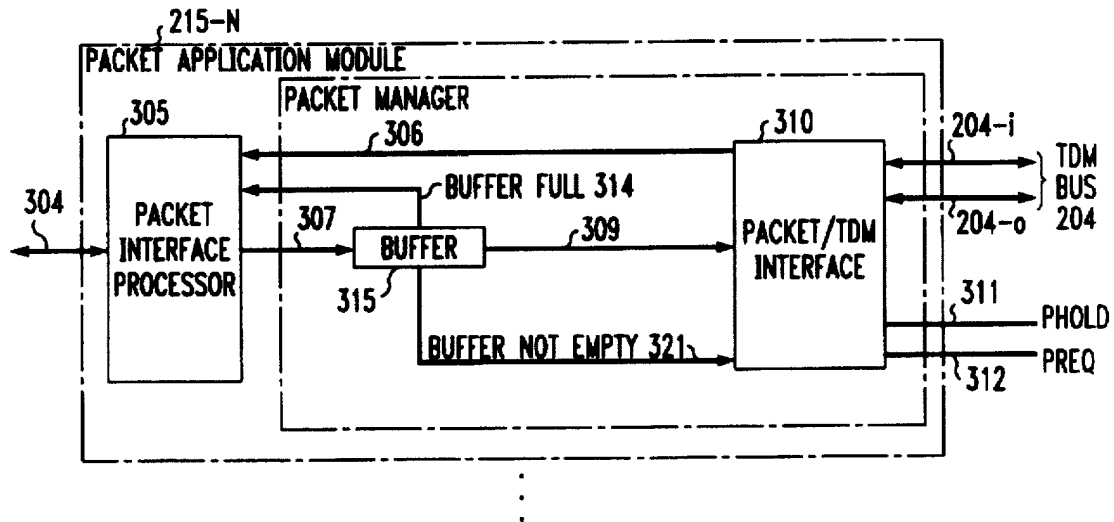


FIG. 5

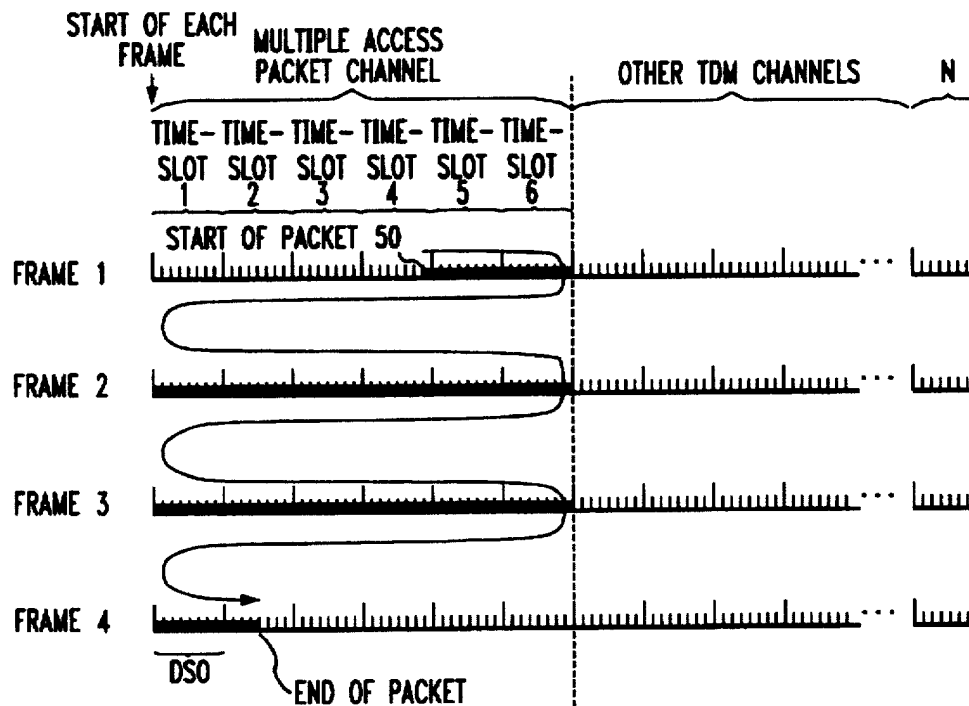


FIG. 6

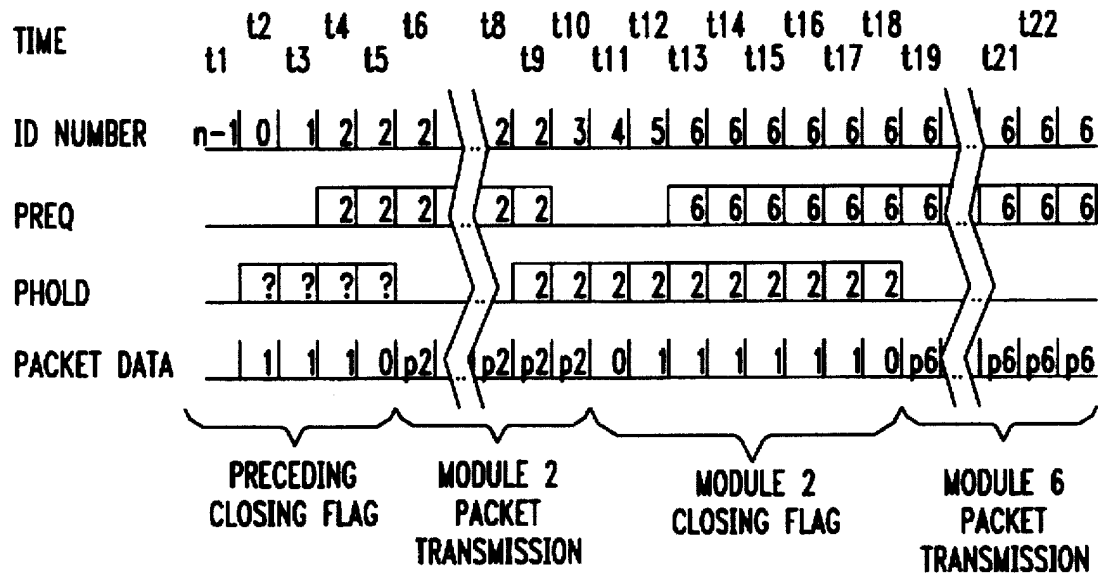


FIG. 7

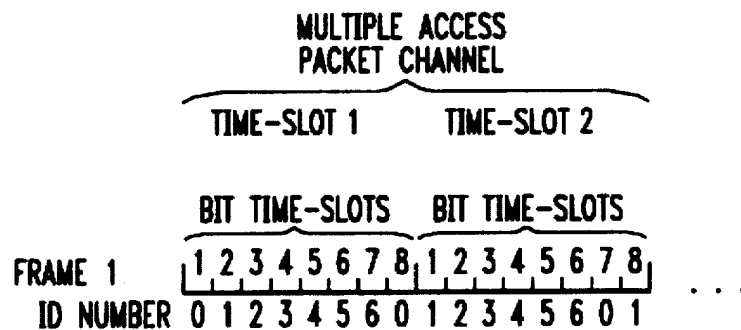


FIG. 8A

INITIALIZE

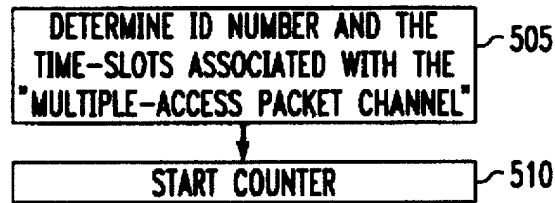


FIG. 8B

REQUEST TO TRANSMIT A PACKET

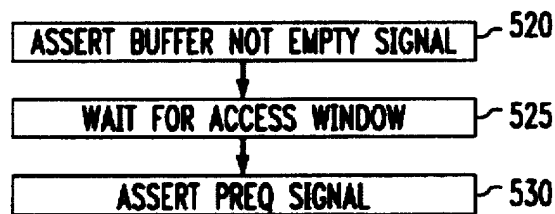
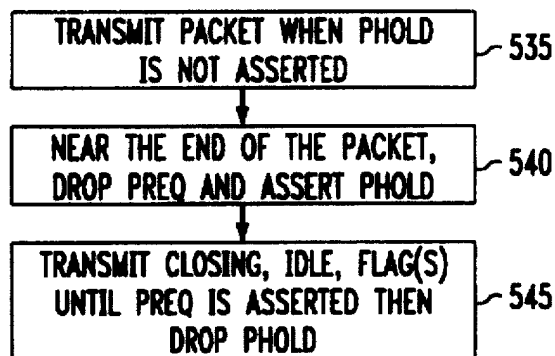


FIG. 8C

WAIT FOR PHOLD



5,719,858

1

TIME-DIVISION MULTIPLE-ACCESS METHOD FOR PACKET TRANSMISSION ON SHARED SYNCHRONOUS SERIAL BUSES

BACKGROUND OF THE INVENTION

The present invention relates to data communications, and more particularly, to communications systems that have channelized network access, and may transport both synchronous data and variable-bit-rate data such as frame relay (hereafter referred to as packet data), in a time-division multiplexed format.

Communications equipment horn as a "network access unit" (NAU) typically provides frame-relay-type services between a local communications network and a network facility, like a T1 facility. The NAU manages the flow of data between the local communications network and the network facility in both directions. To provide the most flexibility, it is preferable that the NAU support two types of data: synchronous data and packet data. For example, the support of synchronous data provides the ability to make telephone, i.e., voice, calls, while the support of packet data provides the ability to interwork with public network packet services. However, the asynchronous nature of packet data at the logical level combined with the requirements of synchronous data causes design tradeoffs in both the complexity and cost of an NAU.

One prior art approach of designing an NAU to support both synchronous data and packet data is shown in FIG. 1. NAU 100 includes network access module 115-1 105, synchronous application modules 120-1 to 120-n, packet application modules 115-1 to 115-n, and packet manager 110. NAM 105 provides the interface between time-division-multiplexing (TDM) bus 104 and network facility 106, which is representative of a T1 facility. The synchronous application modules couple synchronous data equipment (not shown), e.g., telephone equipment, to NAM 105 via TDM bus 104. The packet application modules couple packet data equipment (not shown), e.g., a data terminal, to packet manager 110. The latter is a common resource module that performs internal aggregation in one direction, and distribution in the other direction, of packet streams between NAM 105 and each packet application module, via TDM bus 104 and wideband packet buses 116-1 to 116-n, respectively. In this context, each wideband packet bus is transmitting packet data in parallel, e.g., a "byte" at a time, in contrast to TDM bus 104, which is a serial bus, i.e., it transmits data a bit at a time. As a result of coupling the packet data to the TDM bus, packet manager 110 provides a single multiplexed packet stream to NAM 105 for transmission across the network interface. It should be understood that the network interface bandwidth is "channelized" and, in the context of packet data, expects a single multiplexed packet stream.

NAU 100 is representative of a mixed TDM and packet NAU architecture. In this approach, NAU 100 provides a TDM bus in conjunction with one or more packet buses which taken together provide more bandwidth than is required to support the network interface. This additional bandwidth is used to support multiple point-to-point packet connections. Packet manager 110 not only aggregates the packet data, as mentioned above, but also allocates a fixed amount of the TDM bandwidth to the packet application modules.

Unfortunately, the instantaneous, or peak, data rate of all outbound packet streams taken together may be greater than the "fixed amount of TDM bandwidth" allocated for packet

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data on the network interface. These peak data rates create a large demand on both the overall packet bus capacity and on the packet handling requirements of packet manager 110. For example, once the packet application modules exceed their allocated network interface bandwidth, packet manager 110 must take steps to prevent the loss of any packet data. These steps include buffering the packet data, which may require a buffer of considerable size to support all of the packet application modules, and, perhaps, flow control to throttle the packet traffic. As a result, the complexity of packet manager 110 increases not only with the number of packet application modules that packet manager 110 must support but also with the respective data rate requirements of these packet application modules.

Another prior art approach is illustrated in FIG. 2, which is similar to FIG. 1 except that separate point-to-point wideband packet buses have been replaced with separate TDM channels between each packet application module and the packet manager. In particular, packet application modules 165-1 to 165-n are coupled to TDM bus 154, along with packet manager 170. Each packet application module communicates data to, and from, packet manager 170 in a separate TDM channel as represented by lines 171 and 172. Like the description above for FIG. 1, packet manager 170 aggregates the packet traffic to NAM 155 via a TDM channel, as represented by line 173, to create a single multiplexed packet stream.

Unfortunately, this approach has the above-mentioned problems with respect to the packet manager and, in addition, drives up the bandwidth requirement of the TDM bus. For example, the TDM bus must now support the peak rate of each packet application module on each TDM channel in addition to a TDM channel for the aggregate packet data stream provided by packet manager 170. Conversely, if the TDM channels are limited to a fixed fraction of the allocated network interface bandwidth, a single packet application module would never be able to peak near the full rate when other packet application modules have little or no traffic.

SUMMARY OF THE INVENTION

I have realized an alternative approach to the design of TDM-based equipment that supports both synchronous data and packet data and, in addition, provides an efficient substrate for packet handling. In particular, multiple packet data sources share a single TDM channel. As a result, no central packet manager is required to aggregate the packet data.

In an embodiment of the invention, a plurality of packet data sources, e.g., packet application modules, and synchronous data sources, e.g., synchronous application modules, are coupled to the same TDM bus for communicating data to a network access module. In particular, a portion of the TDM bandwidth allocated to packet data is treated as a "multiple-access packet channel." This allows packet application modules on the TDM bus to share, and contend for, the entire TDM bandwidth allocated to packet data. Each packet application module includes its own TDM bus interface and the network access module receives a single, continuously multiplexed, packet stream for transmission to an opposite endpoint. In the receiving direction, each packet application module accepts the entire received packet stream from the network access module and either filters the packets using their address field or transparently forwards the packet data to a packet service.

In a feature of the invention, a contention scheme for accessing the "multiple-access packet channel" is described

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that avoids packet collisions, maximizes bandwidth efficiency, and provides for interframe High-level Data Link Control (HDLC) flags.

This invention provides the following advantages: no central packet manager is required to synchronize packet data to the TDM bus; packet sources share all of the TDM bandwidth allocated to packet data resulting in maximum efficiency; there is no additional overhead required for packet addressing on the bus; packet buffering is distributed across the bus, rather than being fixed in a central location; and the system has "modularity" and can quickly grow simply by adding additional packet application modules.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows a block diagram of a prior art mixed TDM and packet network access unit;

FIG. 2 shows a block diagram of another prior art time-division-multiplexing-only network access unit;

FIG. 3 shows an illustrative block diagram of a time-division-multiplexing-only network access unit in accordance with the principles of the invention;

FIG. 4 shows a block diagram of a packet application module in accordance with the principles of the invention;

FIG. 5 shows a representation of a sequence of time-division-multiplexing frames in accordance with the principles of the invention;

FIG. 6 is an illustration of a packet arbitration scheme for use in the network access unit of FIG. 2 in accordance with the principles of the invention;

FIG. 7 is an illustration of counting bit time-slots in the "multiple-access packet channel;" and

FIGS. 8A-8C are illustrative flow diagram of a method in accordance with the principles of the invention for use in the packet application module of FIG. 4.

DETAILED DESCRIPTION

An illustrative block diagram of an NAU embodying the principles of this invention is shown in FIG. 3. NAU 200 provides access to a T1 facility for frame relay services as well as synchronous data transport. For simplicity, data endpoints, synchronous or packet, are not shown. NAU 200 includes network access module (NAM) 205, synchronous application modules 220-1 to 220-n, and packet application modules 215-1 to 215-n. NAM 205 provides the interface between TDM bus 204 and network facility 206, which is representative of a T1 facility. The synchronous application modules couple synchronous data equipment (not shown), e.g., telephone equipment, to NAM 205 via TDM bus 204, as is known in the art. In accordance with the inventive concept, multiple packet application modules now share a single TDM channel (described below). Each of the plurality of packet application modules couple packet data equipment (not shown), e.g., a data terminal, to TDM bus 204, and the packet manager is eliminated. Indeed, the function of the packet manager is now distributed among the various packet application modules that created the need for it in the first place. This distribution of the packet manager is represented by the inclusion of packet managers 216-1 through 216-n in the respective packet application modules.

A block diagram of illustrative packet application module 215-n is shown in FIG. 4. Other than the inventive concept, the components of packet application module 215-n are well-known and will not be described in detail. Packet application module 215-n includes packet interface processor 305, buffer 315, and packet/TDM interface 310. The

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latter is an "application specific integrated circuit" (ASIC), which is a programmable large-scale integrated circuit device that is dedicated to performing a specific function, or application, which in this case is described below. Packet interface processor 305 communicates packet data between packet/TDM interface 310 and line 304. The latter is representative of any one of a number of facilities for coupling packet application module 215-n to a packet system. For example, line 304 could be a local area network, or a dedicated facility to a "router" or a packet data terminal. Packet interface processor 305 performs packet handling, e.g., it provides the physical and link layer connections for packet transmission as known in the art, e.g., it checks for addresses, errors, etc., on the packets. Packet data transmitted to a far-end packet endpoint is provided from packet interface processor 305 to packet/TDM interface 310 via line 307, buffer 315, and line 309. It is assumed that lines 307 and 309 are representative of wideband data buses as known in the art. In the other direction, packet data from a far-end packet endpoint is received by packet interface processor 305 from packet/TDM interface 310 via line 306. Packet interface processor 305 receives a BUFFER FULL signal via line 314 from buffer 315, which provides a BUFFER NOT EMPTY signal via line 321 to packet/TDM interface 310. In accordance with the principles of the invention, packet/TDM interface 310 synchronizes packet data retrieved from buffer 315 for insertion into an appropriate time slot on TDM bus 204. The latter is shown as actually comprising two TDM buses. TDM bus 204-o is used for "outbound" traffic through NAM 205 to network interface 206. Conversely, TDM bus 204-i is used for "inbound" traffic from the network. Typically, in the art, TDM bus 204-i and 204-o are symmetrical, e.g., if time-slot 0 is used for status and control information on the "inbound" TDM bus, time-slot 0 of the "outbound" TDM is similarly used for status and control information.

The storage size of buffer 315 is determined empirically and is a function of the type of packet equipment and its data rate. For example, if a packet application module is interfacing to a router, as known in the art, a router may communicate packet data on the order of 128 Kb/sec. Consequently if the packet application module cannot, for the moment, transmit a packet from the router to the TDM bus, the packet application module can perform flow control with the router with a concomitant minimal amount of buffering required on the packet application module because of the low data rate from the router. Conversely, if a packet application module is interfacing to a LAN, which typically communicates data at a higher speed, e.g., 10 Mb/sec., a larger amount of buffering may be required on the packet application module. Thus, depending on the packet equipment, each packet application module may have different buffering requirements—but each packet application module has less buffer requirements than the packet manager module of the prior art.

In accordance with the invention, a portion of the bandwidth of TDM bus 204 is pre-assigned to all the packet data. In particular, this packet-dedicated portion of the bandwidth is referred to herein as a "multiple-access packet channel," which is shared among at least two of the packet application modules. This is in contrast to allocating a fixed fraction of the TDM bandwidth to each packet application module. The "multiple-access packet channel" provides a single channel for communicating all packet data to, or from, NAM 205. In effect, this "multiple-access packet channel" resembles a packet "local area network" (LAN) in many respects, except that the bandwidth of the "multiple-access packet channel"

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is closely matched (or equal) to that allocated for packet traffic across network facility 206. In this case, each packet application module must contend for the bandwidth of the "multiple-access packet channel" with the other packet application modules. (Although, the nature of a TDM bus prevents any packet application module from using more bandwidth than is available from the network, this approach makes the entire network bandwidth allocated to packet data dynamically available to each packet application module as a channel for the transport of packet data.)

NAM 205 communicates to all application modules and controls time-slot allocation among the synchronous modules and the packet modules. The control of time-slot allocation can be performed either over TDM bus 204 or another bus (not shown). In this example, it is assumed that a portion of the TDM bus bandwidth is allocated to control and status information, as known in the art. In accordance with the principles of the invention, the time-slots allocated by NAM 205 to the packet application modules are the "multiple-access packet channel."

In this example, it is assumed that every time-frame is comprised of a plurality of 64 Kbit (DS0) channels, and it is assumed that the "multiple-access packet channel" is any grouping of these DS0 channels. Although not a requirement, it is also assumed that the "multiple-access packet channel" is composed of a subset of contiguous DS0 channels available on the bus. In this case, this corresponds to time-slots 1, 2, 3, 4, 5, and 6, of every frame. The remaining time-slots are allocated to synchronous data and control/status information. The allocation of the above-mentioned six time-slots yields a "multiple-access packet channel" with a bandwidth of 384 Khz. The number of DS0 channels allocated on the inbound and outbound data highways are assumed to be the same, so that equal bandwidth is assured in both directions. (As described above, it is assumed that TDM bus 204-i and TDM bus 204-o are symmetrical, i.e., time-slots 1 through 6 are used for the "multiple-access packet channel" for inbound and outbound traffic.) Finally, it is assumed that this 384 Khz bandwidth is equal to the bandwidth allocated over the network facility for the same packet traffic, i.e., NAM 205 is not required to buffer the packet data.

In accordance with a feature of the invention, it is assumed that packet transmission is utilizing HDLC, which is a bit-oriented layer 2 protocol that produces variable bit length packets. This allows a packet to be spread across time-slots and multiple TDM frames. The "multiple-access packet channel" in this case can be considered a continuous sequence of bits with no framing boundaries other than those of the protocol. As such, the starting point of a packet may lie anywhere in the "multiple-access packet channel." An illustrative sequence of frames is shown in FIG. 5. Frame 1 includes time slots 1 through N, where, as mentioned above, each time-slot represents a 64 Kbit DS0 channel. In this example, it is assumed that N is equal to 64 time-slots. Each frame repeats every 125 micro-seconds and each time-slot is further broken down into a sequence of 8 bits as shown in FIG. 5. Each bit is hereafter referred to as a "bit time-slot." It should be noted that the term "time-slot" refers to a collection of "bit time-slots." Time-slots 1-6 represent the "multiple-access packet channel." As described above, since HDLC is a bit-oriented layer 2 protocol, this allows the packet data to begin and end anywhere in a time-slot. Consequently, each packet is mapped into a plurality of "bit time-slots" within time-slots 1 through 6 on TDM bus 204, rather than the DS0 channels representing each time-slot as a whole. This is illustrated in FIG. 5, where packet 50 begins

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with "bit time-slot" 7 in time-slot 4, of frame 1, and ends with "bit time-slot 3" in time-slot 2 of frame 4. As illustrated by the starting and ending time of packet 50, of FIG. 5, these bit intervals do not have to conform to time slot boundaries into which the packets are mapped and inserted.

As described above, each packet application module must contend for the "multiple-access packet channel." If a packet application module "grabs" the "multiple-access packet channel" that packet application module then transmits using the full 384 Khz of bandwidth. However, if a packet application module cannot "grab" the "multiple-access packet channel," then that packet application module must queue, or buffer, the packet. As a result, the flow control is now distributed among the packet application modules.

The properties desired for packet transport on the "multiple-access packet channel" are high bandwidth efficiency and deterministic fairness. Bandwidth efficiency is a measure of how closely the packet utilization of the available (fixed) TDM bandwidth matches the offered packet load. It also measures efficiency of the channel as the offered packet load exceeds the available bandwidth. Fairness describes how a chosen priority scheme affects the comparative delay of packets through the system under bandwidth contention with multiple packet sources.

Any method used for implementing a "multiple-access packet channel" should be designed to achieve as close to 100% bandwidth efficiency as possible with no negative throughput effects due to congestion. The method should also have no inherent priority bias among the packet sources so that priorities may be enforced selectively if needed, preferably in software on the packet application modules. These properties are only applicable to the outbound (toward the network) direction, where multiple packet sources are contending for a fixed network pipe. Inbound packet data is already multiplexed as a single packet stream within the network channel. Since the TDM bus 204 is full duplex, as represented by separate data highways TDM bus 204-i and TDM bus 204-o, NAU 200 may have an asymmetric access protocol. That is, the access protocol for the inbound direction can be different from the access protocol described below for the outbound direction. In the context of this invention, it is assumed that all modules are continually listening to the TDM in-bound bus to pull off data addressed to them. In the case of the packet application modules, it is assumed that each packet application module is monitoring, or listening to, the "multiple-access packet channel" for packets that have addresses associated with that packet application module. A packet application module listens for its header, e.g., virtual address, if it is not their packet, it is just dropped. The remainder of this description will focus on outbound packet traffic.

In accordance with the invention, a Time-division Multiple Access with Collision Avoidance (TDMA/CA) scheme is used for the outbound direction to regulate access to the "multiple-access packet channel." In particular, the synchronous property of TDM bus 204 provides the means to implement a slotted-access method to avoid collisions. This slotted-access method enables each packet application module to contend for the "multiple-access packet channel," and avoid packet collisions, in a fair and efficient manner. In this embodiment, the slotted-access method is implemented by packet/TDM interface 310 of each packet application module.

Before describing it in detail, an overview of this slotted-access method is described. In the slotted-access method, each packet application module, in rotation order, is given an

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"access window" of time, corresponding to a "bit time-slot" on the TDM bus, to either capture the "multiple-access packet channel" for transmission, or defer and allow the "access window" to advance to the next packet application module in order. Once granted access, that packet application module has sole access to the "multiple-access packet channel" for a period of time, referred to herein as the "access period." During this "access period," a packet application module sends at least one HDLC frame of queued packet traffic toward the network, and the "access window" is frozen at the current packet application module and does not advance until that packet application module releases the "multiple-access packet channel." Under some conditions however, a packet application module may not begin transmitting packet data as soon as it has captured the "multiple-access packet channel." In particular, whenever the previously transmitting packet application module is still transmitting a packet or closing flag, the next packet application module must wait until completion before transmitting its first packet. Since a rotational arbitration scheme on the bus may take several "bit time-slots," or clock, intervals, this mechanism allows the arbitration to overlap an active packet transmission, avoiding idle time on the bus and increasing bandwidth utilization.

FIG. 6 shows an illustrative slotted-access method. There is an implied numbering of the packet application modules and "bit time-slots." This implied numbering is hereafter referred to as an "ID number." Generally speaking, a packet application module can attempt to access TDM bus 204-o only when the ID number of the "bit time-slot" matches the ID number of the packet application module. In a system with N packet application modules, each "bit time-slot" of the "multiple-access packet channel" is counted in a repeating sequence from 0 to N-1 starting at some arbitrary "bit time-slot" by each packet application module. In other words, each packet application module only counts those "bit time-slots" assigned to the "multiple-access packet channel." The value of the count is the ID number for the "bit time-slot." All packet application modules are synchronized with this counting sequence and are aware of the ID number of each "bit time-slot" at all times. As a result, the ID number need not be present on the bus. As noted earlier, each packet application module knows, a priori, the time-slots associated with the "multiple-access packet channel." In combination with this, each packet application module is configured with an unique ID number, which can be determined in any number of ways. For example, each module, or circuit board, can have an address associated either via a "software-controlled" configuration, e.g., a system administrator literally assigns addresses to the various modules; or by a hardware setting that specifically associates a particular address with a particular position in the system, e.g., what slot the circuit board is plugged into. Note, this counting of "bit time-slots" may span more than one frame. Since N may be any integer there is no relationship between this ID numbering and the position of bits in the TDM frame.

For example, if there are seven packet application modules, and assuming for the moment that none of the seven packet application modules wanted access to the TDM bus, this counting would look like that shown in FIG. 7. FIG. 7 is similar to FIG. 5, except packet 50 has been removed, i.e., there is no transmission of a packet and only time-slots 1 and 2 of frame 1 are shown. It is assumed that each packet application module counts "bit time-slots" of the "multiple-access packet channel" beginning with "bit time-slot" 1 of frame 1, which is associated with the count value of 0. Each packet application module waits for its ID number to equal

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the count, or ID number, of the "bit time-slot" to attempt to access TDM bus 204-o. For example, the packet application module associated with ID 0, can attempt access only upon the value of the count equaling 0, which, in this example, occurs in "bit time-slot" 1 of time-slot 1 of frame 1, "bit time-slot" 8 of time-slot 1 of frame 1, "bit time-slot" 7 of time-slot 2 of frame 1 etc.

To implement this slotted-access method two additional signals are bussed between packet application modules. These signals are "packet request" (PREQ) and "packet hold" (PHOLD). It is assumed these signals are bussed among the packet application modules as simply "open collector" as known in the art which allows them to be logically "OR"ed. Referring back to FIG. 6, a sequence of "bit time-slots" is shown. This sequence of bit time-slots only represents those "bit time-slots" assigned to the "multiple-access packet channel." The top row of FIG. 6 is simply a sequence of bit time reference points. The second row of FIG. 6 is the ID number of the "bit time-slot" of the "multiple-access packet channel," i.e., the value of the count. The next two rows represent the state of the PREQ and PHOLD busses. The final row simply represents packet data.

Beginning at time t2, the "bit time-slot" ID number is equal to 0. In order for a packet application module to transmit a packet on TDM bus 204-o, the packet application module must assert the PREQ signal whenever the ID numbers of the "bit time-slot" and the packet application module match. Upon receiving the PREQ signal, each packet application module halts the counting. The packet application module that asserted the PREQ signal becomes the next in line to begin transmission. For example, when the packet application module associated with the ID number of 2 wants to transmit, it must wait until time t4, when the ID numbers of the "bit time-slot" and the packet application module match, to assert the PREQ signal. However, the presence of a PHOLD signal driven by the currently transmitting packet application module delays the access of packet application module 2 to TDM bus 204-o until PHOLD is withdrawn at time t5. (The question marks illustrated in FIG. 6 simply represent that another, unidentified packet application module is currently transmitting.) At the next "bit time-slot," t6, packet application module 2 concatenates its packet stream with that of the previous transmission.

Although it could occur at any point, it is assumed that packet application module 2 drops the PREQ signal at the end of its packet transmission (described below) to allow the counting of time-slots by all packet application modules to again advance. At the same time, packet application module 2 asserts the PHOLD signal, which prevents the next packet application module from beginning its transmission until packet application module 2 has completed its closing flag sequence. These events occur at time t9. Subsequently, packet application module 6 raises its PREQ signal at time t13, signaling its readiness to send at least one packet, while packet application module 2 is still transmitting its closing flag. At time t18, packet application module 2 completes its packet transmission and drops PHOLD. At time t19, packet application module 6 begins sending its packet data.

It should be noted that the HDLC flags are a byte in length. Consequently, transmission of an HDLC inter-frame flag must end first before another packet application module can get the TDM bus 204-o to insert data. In addition, and in accordance with HDLC, the last packet application module may continue inserting the inter-frame flags, and asserting the PHOLD signal until the PREQ signal is asserted, by

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itself or another module. Once the PREQ signal is asserted, TDM/packet interface 310 drops the PHOLD signal only when the insertion of the current flag is finished.

As mentioned above, the point at which an actively transmitting packet application module asserts the PHOLD signal and lowers the PREQ signal is arbitrary. The earlier this occurs, the higher the probability that the next packet application module will be found by the time the first closing flag sequence is sent. This increases the efficiency of the "multiple-access packet channel" because there is no waiting for data transmission to finish to start arbitration again, i.e., no time is lost for contention (a packet application module is always ready to go). On the other hand, waiting until near the end of the transmission allows more timely packet queue information to be used in the arbitration. A balance between these two extremes could be implemented.

A method illustrating this slotted-access technique for use in the packet application module of FIG. 4 is shown in FIG. 8. The steps shown in FIG. 8 have been divided into different "subroutines" for simplicity, i.e., an "initialize subroutine" (FIG. 8A), "request to transmit a packet subroutine" (FIG. 8B), and a "wait for PHOLD" subroutine (FIG. 8C). In step 505, packet application module 215-n is initialized, e.g., via a power-up sequence, and determines its ID number, e.g., via a hardware strap or software configuration. During this initialization, NAM 205 of FIG. 3 allocates the time-slots associated with the "multiple-access packet channel." Packet/TDM interface 310 uses the assignment information from NAM 205 as the synchronizing signal to begin counting "bit time-slots" of the "multiple access packet channel" in step 510 (provided that the PREQ signal is not asserted). In this example, it is assumed that packet/TDM interface 310 includes a counter to count each "bit time-slot" of TDM bus 204-o that is associated with the "multiple-access packet channel." The counter included within packet/TDM interface 310 rims continuously and is controlled by the PREQ signal, i.e., if PREQ is asserted—no counting takes place and the count holds at the last value.

When there is a packet to transmit, packet interface processor 305 begins to fill buffer 315 provided buffer 315 is not full. In particular, referring briefly back to FIG. 4, it can be seen that a BUFFER FULL signal is provided by buffer 315 to packet interface processor 305. This signal alerts packet interface processor 305 if buffer 315 is full. As a result, packet interface processor 305 fills buffer 315 when packet data is available to transmit only if the BUFFER FULL signal is not active. Once the BUFFER FULL signal is active, packet interface processor 305 could, if necessary, perform flow-control, if possible, with the associated packet endpoint like a router, or simply begin dropping packets. Assuming buffer 315 is initially empty, as packet interface processor 305 begins to fill up buffer 315, the BUFFER NOT EMPTY signal is asserted for TDM/packet interface 310 in step 520, via line 321.

Upon receiving the BUFFER NOT EMPTY signal, TDM/packet interface 310 waits for the "access window" in step 525. Once the "access window" matches, i.e., the ID number of packet application module 215-n matches the current value of the counter, i.e., the "bit time-slot" ID number, TDM/packet interface 310 asserts the PREQ signal in step 530.

In step 535, TDM/packet interface 310 waits until PHOLD is no longer asserted before transmitting the packet from buffer 315 onto TDM bus 204-o. Upon nearing the end of the packet transmission (which can be determined simply by knowing the length of the packet from the packet header

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information), TDM/packet interface 310 drops the PREQ signal and asserts the PHOLD signal in step 540. As mentioned above, the last packet application module to grab the "multiple-access packet channel" continues inserting flags and asserting PHOLD until PREQ is asserted, by itself or another module. Once PREQ is again asserted, TDM/packet interface 310 drops PHOLD only when the insertion of an flag is finished. At this point the next packet application module then has access to the "multiple-access packet channel."

Within this general method, different approaches may be taken to offset the arbitration fairness. In general, each time a packet application module gains transmission access to the "multiple-access packet channel," it may send any prescribed number of packets. The access method may be designed to limit this number to one, or it may allow the application to empty its packet transmit buffer. If the hardware imposes no limit on the size or number of packets sent during one access period, the application software is then able to implement rules for sending varying amounts of packet traffic across the bus. There is no reason why those rules must be applied the same for every packet application module, and in fact could be different for each port.

For example, the packet application module may send as many packets as can be transmitted within a fixed amount of time. Another possibility is that the amount of packet data transmitted may be a function of the number of packets queued or the time they have been queued. The size of the packets, always known to the software, may also be a factor in determining when to terminate the access period.

The only hardware function required to support such strategies is the combination of the PREQ signal and PHOLD signal. Once the active packet application module is about to fulfill its prescribed transmission requirement, the corresponding packet interface processor either informs the respective TDM/packet interface via a control line (not shown) or the TDM/packet interface continues transmitting until a corresponding BUFFER EMPTY signal (not shown) is received by the TDM/packet interface. Whatever the signal, the TDM/packet interface then stops asserting PREQ to allow another packet application module to gain access to the TDM bus.

As noted above, the above description assumed that the packet/TDM interface was incorporated in a single ASIC bus interface chip. This is feasible if bus speeds and capacities are modest, say 10–20 Mbps maximum throughput, and only one packet channel is required. As a result, the use of an ASIC to implement a bus interface chip to integrate these functions should result in minimal additional cost (in quantity). Further, adding support for a second packet channel may be a similar incremental cost. However, boosting the TDM bus capacity to T3 rates or higher will pose the greatest potential cost increase due to higher bus clock rates and the number of 64K channels. At this level, an ASIC having a much larger gate-count may be needed to provide a large number of timeslot registers, increased buffering, and higher speed DMA channels.

The foregoing merely illustrates the principles of the invention and it will thus be appreciated that those skilled in the art will be able to devise numerous alternative arrangements which, although not explicitly described herein, embody the principles of the invention and are within its spirit and scope.

For example, although the invention is illustrated herein as being implemented with functional building blocks, e.g., a packet interface processor, etc., the functions of any one or

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more of those building blocks can be carded out using one or more appropriate integrated circuits.

In addition, although illustrated in the context of a T1 network facility, the inventive concept applies to other network facilities as well, e.g., fractional T1, digital data service (DDS), T3, etc. Further, more than one "multiple-access packet channel," can exist. For example, a first plurality of packet application modules may be assigned to a first group of time-slots, e.g., time-slots 1-6, for transmitting packet data, while a second plurality of packet application modules is assigned to a second group of time-slots, e.g., time-slots 7-12, for transmitting packet data. Also, because the bandwidth of a TDM bus may be divided into many separate logical channels, data with different formats and access methods, such as isochronous and packet data, may be combined in the system. Another variation is to use the time-slots to control contention access, as opposed to the "bit-time slots," described above.

It should also be noted that the inventive concept is applicable to Asynchronous Transfer Mode (ATM) transmission. In particular, ATM cells are handled in a similar manner, although not on the same "multiple-access packet channel" carrying bit-oriented protocols. In the case of ATM cells, the octets which form the cells need to be aligned within DS0 channels. This places an additional constraint on the packet/TDM interface to recognize those boundaries and transmit within them. The "bit time-slots" may still be used in the same manner as describe above for arbitration however. Another property of ATM cells is that they are not delimited by flags. Idle time between cells transporting user data must be filled with null cells. Responsibility for filling voids in the cell stream may be assigned to the packet application modules to perform in a fashion similar to adding flag fills for HDLC protocols described earlier. Alternatively, this could be the responsibility of the NAM on the outbound trunk, especially if the NAM is required to buffer cells in order to map them onto the network link.

What is claimed:

1. Data communications apparatus comprising:
 - a time division multiplexed bus having a bandwidth, where a portion of the bandwidth is allotted to packet data;
 - a plurality of packet data sources coupled to the time-division multiplexed bus that share the allotted bandwidth for transmitting packet data; and
 - a distributed packet manager within each of said packet data sources configured to allocate access to the allotted bandwidth among said packet data sources.
2. The apparatus of claim 1 including a packet arbitration bus comprising a packet request signal and a packet hold signal.
3. The apparatus of claim 2 wherein each packet data source comprises:
 - interface circuitry that inserts packets to the allocated bandwidth of the time-division multiplexed bus and is coupled to the packet arbitration bus; and
 - a packet data processor for providing the packets from a packet endpoint to the interface circuitry.
4. Data communications apparatus comprising:
 - a time-division multiplexed bus having a bandwidth, where a portion of the bandwidth is allocated to packet data;
 - a plurality of packet data sources coupled to the time-division multiplexed bus that share the allocated bandwidth for transmitting packet data;
 - a packet arbitration bus comprising a packet request signal and a packet hold signal;

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interface circuitry coupled to the packet arbitration bus, said interface circuitry inserting packets to the allocated bandwidth of the time-division multiplexed bus, and performing a counting function by counting time-slots of the allocated bandwidth so long as the packet request signal is not asserted; and

a packet data processor for providing the packets from a packet endpoint to the interface circuitry.

5. The apparatus of claim 4 wherein the time-slots are bit time-slots.

6. The apparatus of claim 4 wherein the interface circuitry inserts the packets into the allocated bandwidth when a value of the counter is equal to a predetermined identification number of the respective packet data source and the packet hold signal is not asserted.

7. Communications apparatus comprising:

a time-division multiplexed bus having a predefined bandwidth;

a plurality of synchronous data sources coupled to the time-division multiplexed bus for communicating synchronous data in a first portion of the predefined bandwidth;

a plurality of packet data sources coupled to the time-division multiplexed bus for communicating packet data in a second portion of the predefined bandwidth, where the plurality of packet data sources share the second portion of the predefined bandwidth for transmitting packet data; and

a distributed packet manager within each of said packet data sources configured to allocate access to the second portion of the predefined bandwidth among said packet data sources.

8. The apparatus of claim 7 further including a network access manager coupled to the time-division-multiplexed bus for communicating the synchronous data and the packet data to at least one network facility.

9. Communications apparatus comprising:

a time-division multiplexed bus having a predefined bandwidth;

a plurality of synchronous data sources coupled to the time-division multiplexed bus for communicating synchronous data in a first portion of the predefined bandwidth; and

a plurality of packet data sources coupled to the time-division multiplexed bus for communicating packet data in a second portion of the predefined bandwidth, where the plurality of packet data sources share the second portion of the predefined bandwidth for transmitting packet data, the second portion of the predefined bandwidth being shared in such a way that only one of the plurality of packet data sources accesses the second portion of the predefined bandwidth at a time.

10. The apparatus of claim 7 wherein each one of the plurality of packet data sources includes interface circuitry to the time-division multiplexed bus for synchronizing packet data to the time-division multiplexed bus.

11. Communications apparatus comprising:

a time-division multiplexed bus having a predefined bandwidth;

a plurality of synchronous data sources coupled to the time-division multiplexed bus for communicating synchronous data in a first portion of the predefined bandwidth;

a plurality of packet data sources coupled to the time-division multiplexed bus for communicating packet

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data in a second portion of the predefined bandwidth, where the plurality of packet data sources share the second portion of the predefined bandwidth for transmitting packet data, wherein each one of the plurality of packet data sources includes interface circuitry to the time-division multiplexed bus for synchronizing packet data to the time-division multiplexed bus, and the interface circuitry includes a counter for counting time-slots representing the second portion of the predefined bandwidth.

12. The apparatus of claim 11 wherein the time-slots are bit time-slots.

13. The apparatus of claim 11 wherein the interface circuitry inserts packets into the second portion of the predefined bandwidth when a value of the counter equals a predetermined identification number of a respective packet data source and a hold signal is not being asserted by the interface circuitry of the remaining packet data sources.

14. The apparatus of claim 11 wherein the counter is inhibited from counting when a packet request signal is asserted by interface circuitry from any packet data source.

15. A method for use in a data communications apparatus for transmitting packet data on a time-division multiplexed bus, the method comprising the steps of:

coupling a plurality of packet data sources to the time-division multiplexed bus;

allocating a portion of the bandwidth of the time-division multiplexed bus to the plurality of packet data sources in such a way that the allocated portion is shared among the plurality of packet data sources;

transmitting packet data from the plurality of packet data sources on the allocated portion of the bandwidth; and controlling access by said packet data sources to the allocated portion of the bandwidth via a distributed packet manager within each of said packet data sources.

16. A method for use in a data communications apparatus for transmitting packet data on a time-division multiplexed bus, the method comprising the steps of:

coupling a plurality of packet data sources to the time-division multiplexed bus;

allocating a portion of the bandwidth of the time-division multiplexed bus to the plurality of packet data sources in such a way that the allocated portion is shared among the plurality of packet data sources;

assigning to each one of the plurality of packet data sources an identification number;

counting, in each one of the plurality of packet data sources, a sequence of time-slots representing the allocated portion of the bandwidth; and

transmitting packet data from one of the plurality of packet data sources on the allocated portion of the bandwidth only when the value of the count matches the respective identification number assigned to that packet data source.

17. The method of claim 16, wherein said step of counting a sequence of time-slots representing the allocated portion of the bandwidth is enabled only when none of the plurality of packet data sources assert a packet request signal.

18. The method of claim 16, wherein said step of transmitting packet data from one of the plurality of packet data sources is enabled only if a packet hold signal is not asserted by any other one of the plurality of packet data sources.

19. The method of claim 16, wherein said step of counting a sequence of time-slots representing the allocated portion of the bandwidth further comprises counting bit time-slots.

20. A method for transmitting packet data on a time-division multiplexed bus in data communications equipment, the method comprising the steps of:

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allocating a portion of the bandwidth of the time-division multiplexed bus as a multiple-access packet channel; coupling a plurality of packet data sources to the time-division multiplexed bus;

controlling the access by said packet data sources to the allocated portion of the bandwidth via a distributed packet manager within each of said packet data sources;

transmitting packet data from the one of the plurality of packet data sources having access to the multiple-access packet channel.

21. A method for transmitting packet data on a time-division multiplexed bus in data communications equipment, the method comprising the steps of:

allocating a portion of the bandwidth of the time-division multiplexed bus as a multiple-access packet channel; coupling a plurality of packet data sources to the time-division multiplexed bus;

assigning a unique identification number to each one of the plurality of packet data sources;

counting, in each one of the plurality of packet data sources, a sequence of time-slots representing the multiple-access packet channel;

granting access to the multiple-access packet channel to that one of the plurality of packet data sources that requests access when the value of the count matches the respective identification number of that packet data source; and

transmitting packet data from the one of the plurality of packet data sources having access to the multiple-access packet channel.

22. The method of claim 21 wherein the counting step is enabled only when none of the plurality of packet data sources assert a packet request signal.

23. The method of claim 21 wherein the granting step further includes the step of asserting a packet request signal by the packet data source granted access.

24. The method of claim 21 wherein the counting step counts a sequence of bit time-slots.

25. A method for transmitting packet data on a time-division multiplexed bus for use in data communications equipment, the method comprising the steps of:

allocating a portion of the bandwidth of the time-division multiplexed bus as a multiple-access packet channel; coupling a plurality of packet data sources to the time-division multiplexed bus;

arbitrating between the plurality of packet data sources to grant access to the multiple-access packet channel to one of the plurality of packet data sources at a time; and transmitting packet data from the one of the plurality of packet data sources having access in the arbitrating step only if a packet hold signal is not asserted by another one of the plurality of packet data sources.

26. The method of claim 20 further comprising the step of coupling a network access module to the time-division multiplexed bus for receiving the packet data for transmission over a network facility.

27. A data communications apparatus, comprising: a time-division multiplexed bus with a bandwidth which is split into at least two portions, one of the portions being allocated for packet data;

a plurality of packet data sources coupled to said time-division multiplexed bus, the packet data sources transmitting packet data on said portion allocated for packet data; and

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means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data among the plurality of packet data sources.

28. The apparatus of claim 27, wherein said means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data further comprises a packet arbitration bus having a packet request signal and a packet hold signal, the arbitration bus being coupled to each of the packet data sources, and the packet data sources including means for generating the packet request signal and the packet hold signal.

29. The apparatus of claim 28, wherein said means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data further comprises a means within each packet data source for counting the time-slots of the portion of the time-division multiplexed bus.

30. The apparatus of claim 29, wherein said means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data further comprises the communication of packet data by one of the packet data

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sources when the packet hold signal is not asserted and the value of said counting means is equal to a predetermined identification number assigned to said packet data source.

31. The apparatus of claim 29, wherein said means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data further comprises means for generating the packet request signal by a packet data source wishing to gain access to the time-division multiplexed bus when the value of said counting means is equal to a predetermined identification number assigned to said packet data source, said counting means being stopped by said packet request signal.

32. The apparatus of claim 29, wherein said means for arbitrating access to the portion of the time-division multiplexed bus allocated for packet data further comprises means for releasing said packet request signal and for asserting said packet hold signal by a packet data source while said packet data source is transmitting packet data.

* * * * *

Exhibit 2

United States Patent [19]

King

[11] Patent Number: 4,937,819

[45] Date of Patent: Jun. 26, 1990

[54] **TIME ORTHOGONAL MULTIPLE VIRTUAL DCE FOR USE IN ANALOG AND DIGITAL NETWORKS**

[75] Inventor: Joseph B. King, St. Petersburg, Fla.

[73] Assignee: A.T. & T. Paradyne, Largo, Fla.

[21] Appl. No.: 249,450

[22] Filed: Sep. 26, 1988

[51] Int. Cl.⁵ H04J 3/16

[52] U.S. Cl. 370/95.3; 370/95.1; 370/85.7; 370/104.1

[58] Field of Search 370/96, 90, 85, 86, 370/95, 79, 82, 94, 104, 95.1, 95.2, 95.3, 85.7, 104.1, 94.1; 375/12, 13, 14; 340/825.5, 825.51

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Primary Examiner—Douglas W. Olms

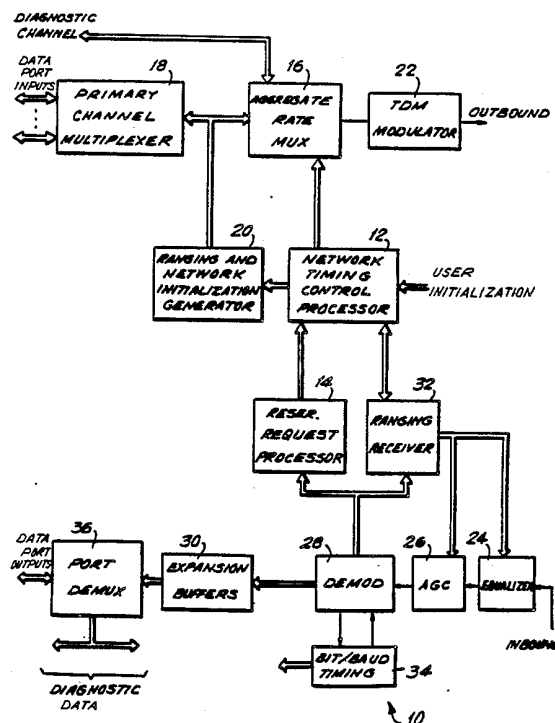
Assistant Examiner—Alpus H. Hsu

Attorney, Agent, or Firm—Kane, Dalsimer, Sullivan, Kurucz, Levy, Eisele and Richard

[57] ABSTRACT

Apparatus and method for time division multiple access in a multidrop system with multiple host applications. Employing half-duplex polled protocols is disclosed. Ranging with respect to time is used so as to reduce guard time between successive transmissions thereby increasing system efficiency. Host applications can request extra time slots for long messages via a request bit within the message format.

15 Claims, 9 Drawing Sheets



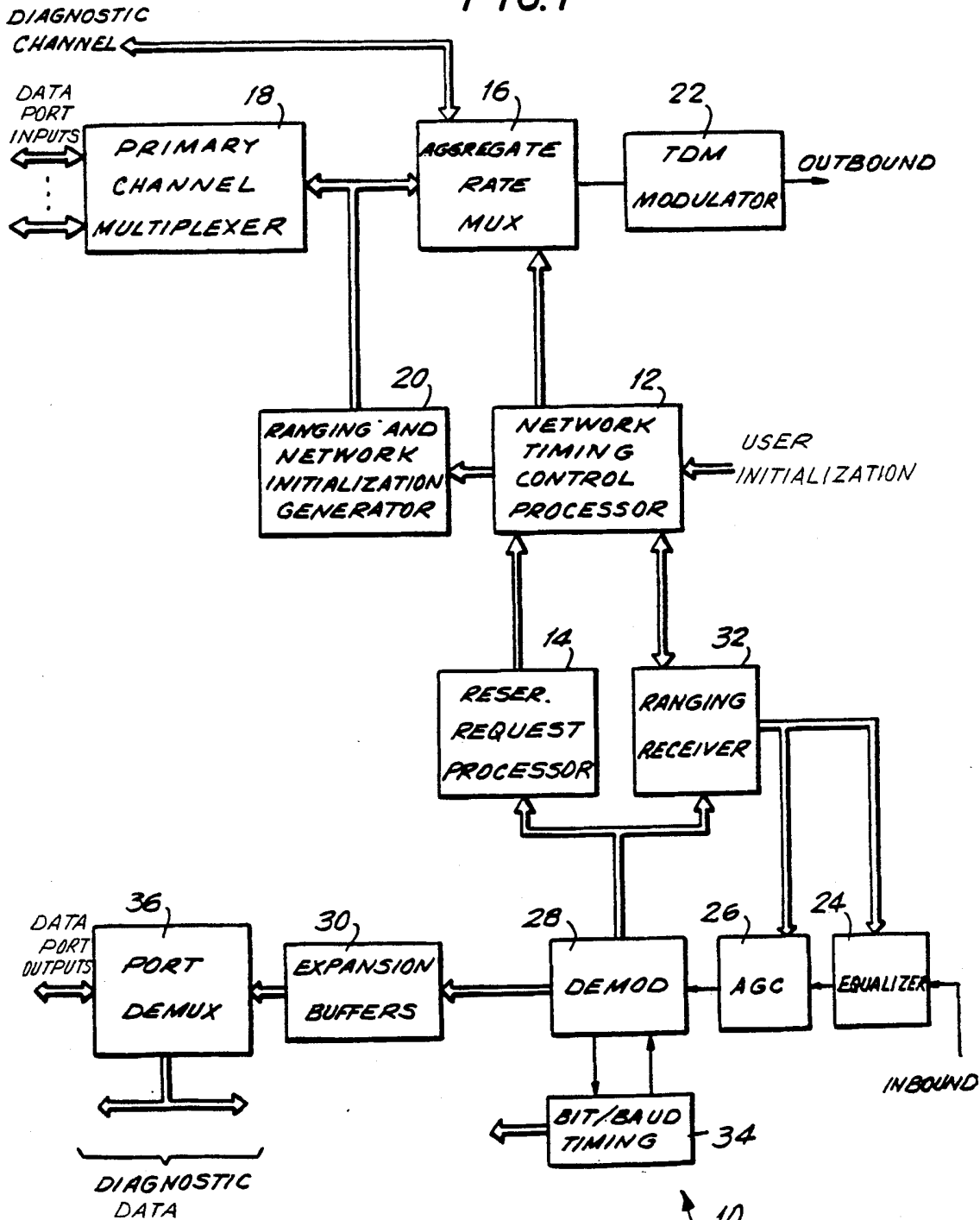
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FIG. 1



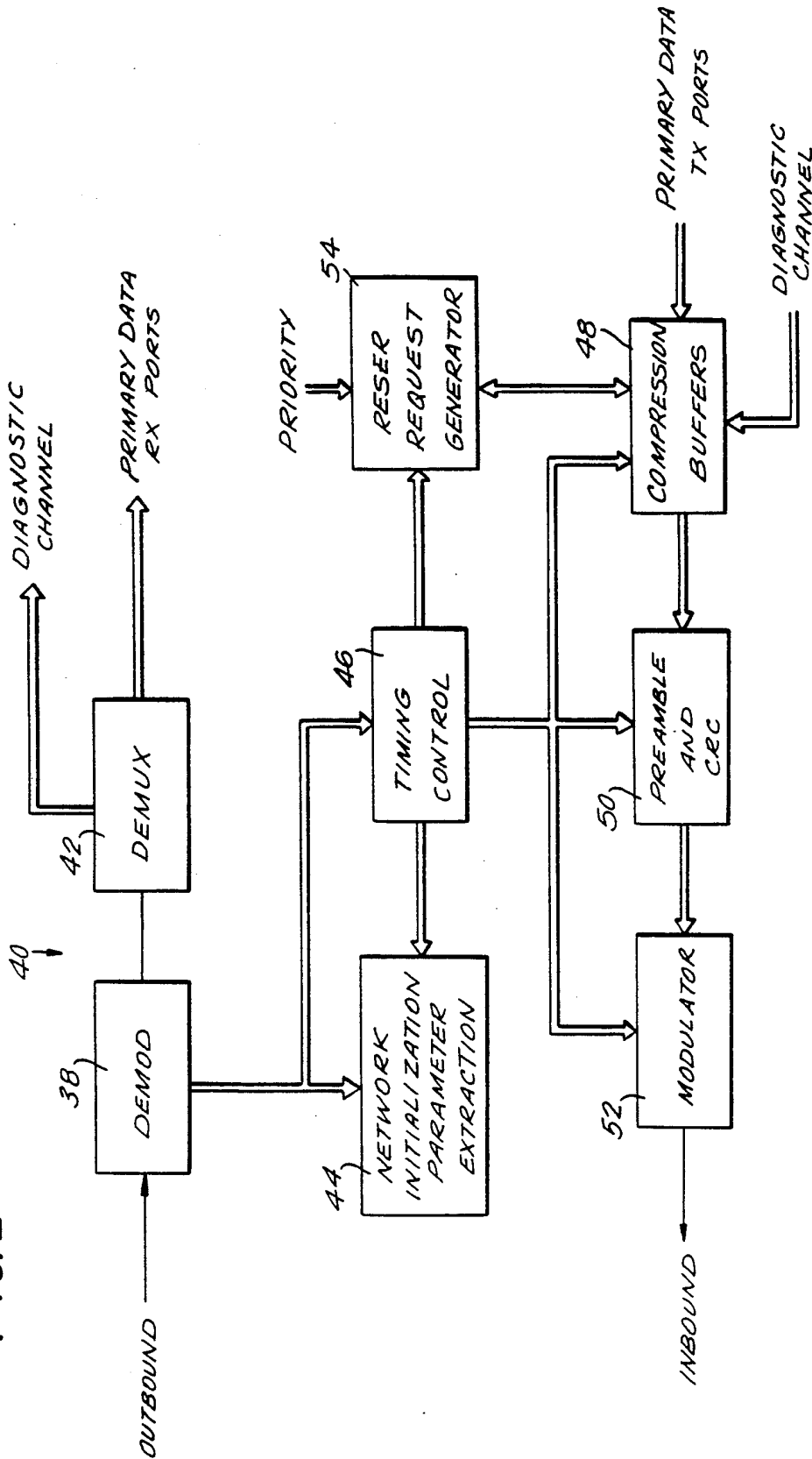
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FIG. 2



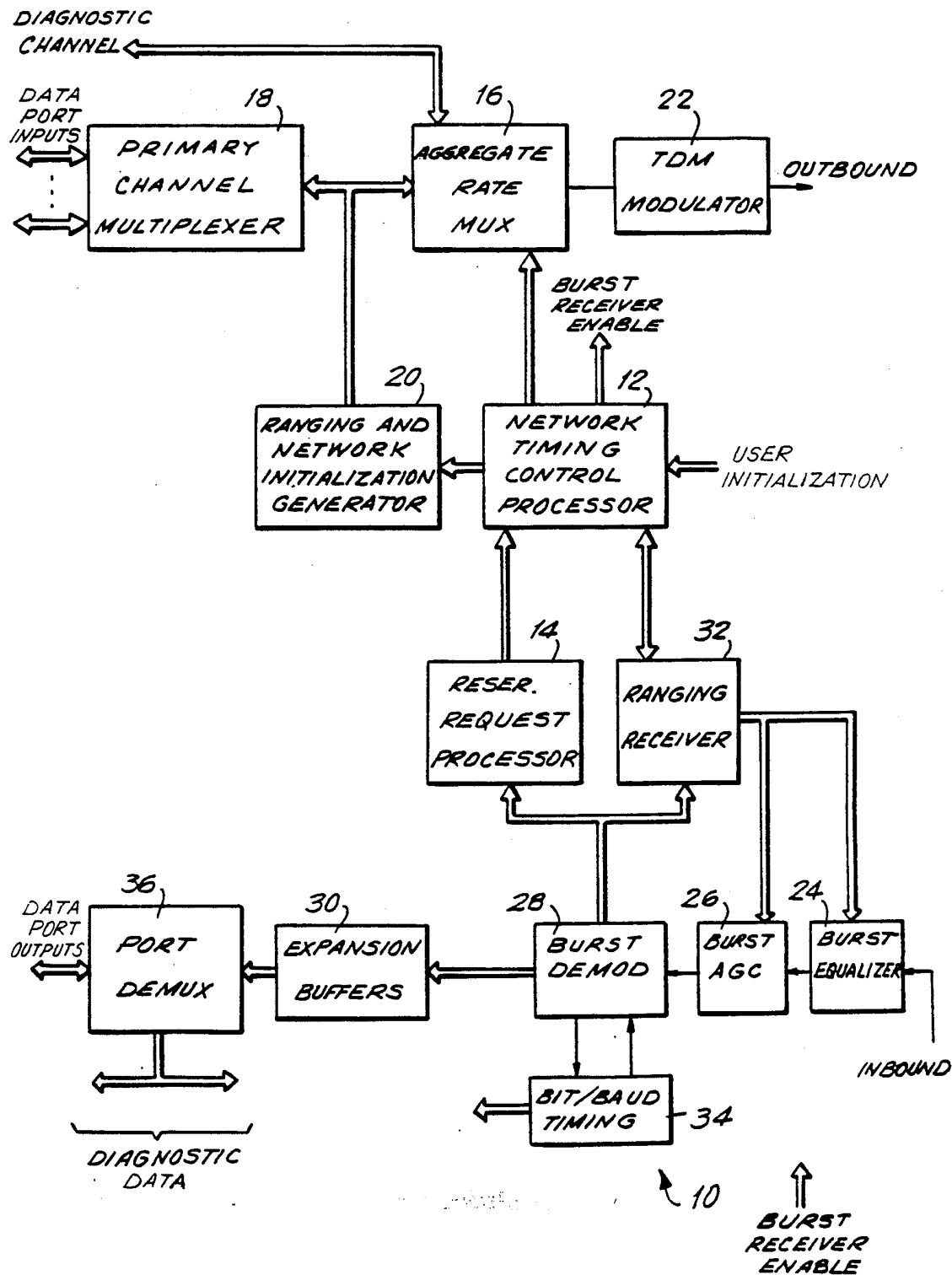
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FIG. 3



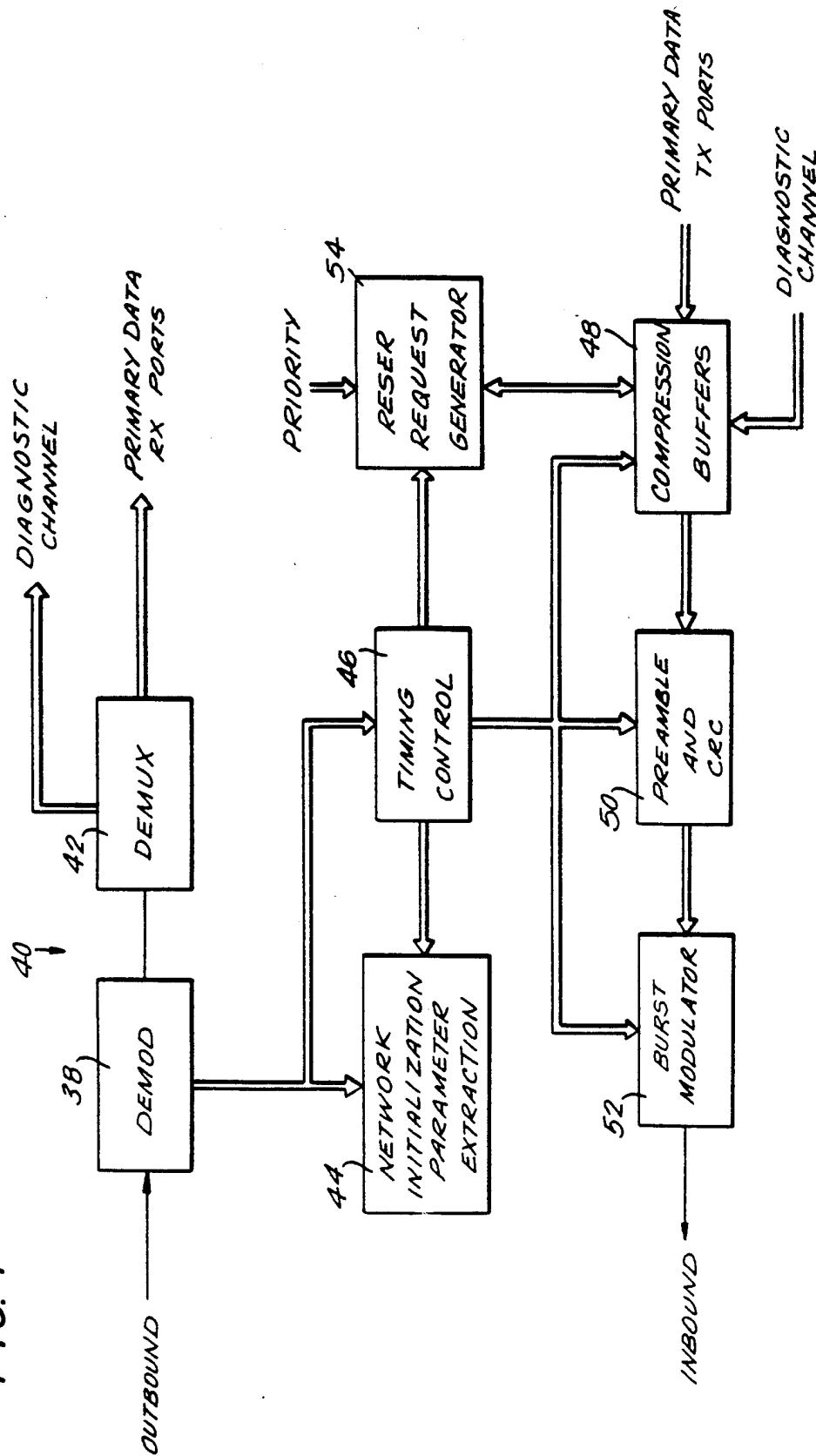
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FIG. 4



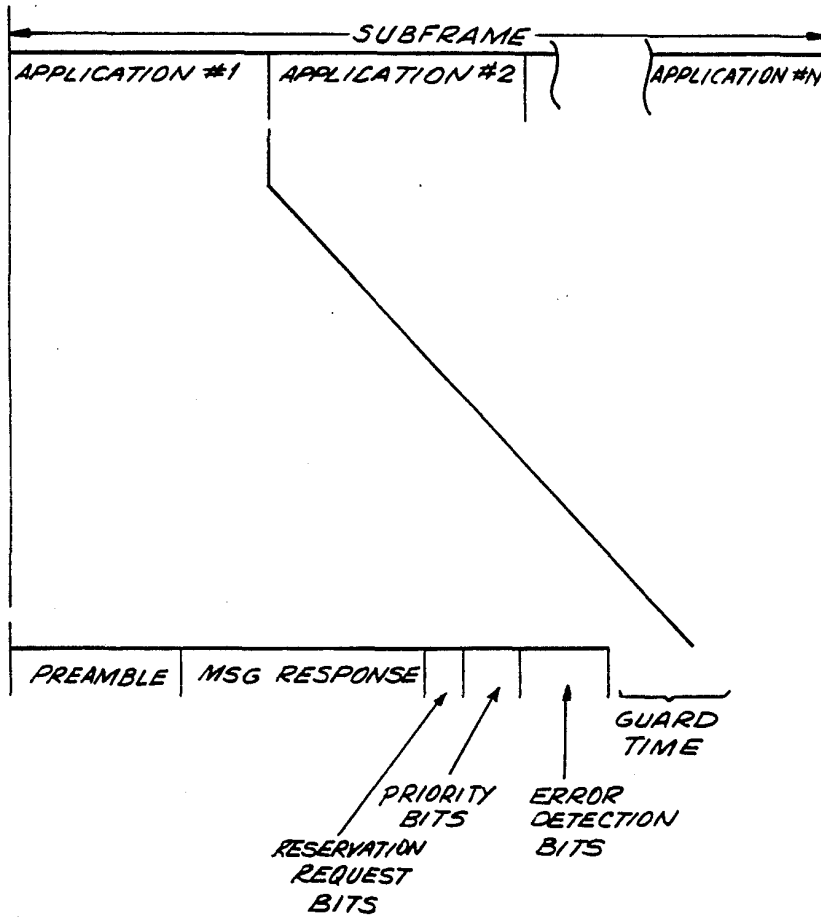
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FIG. 5



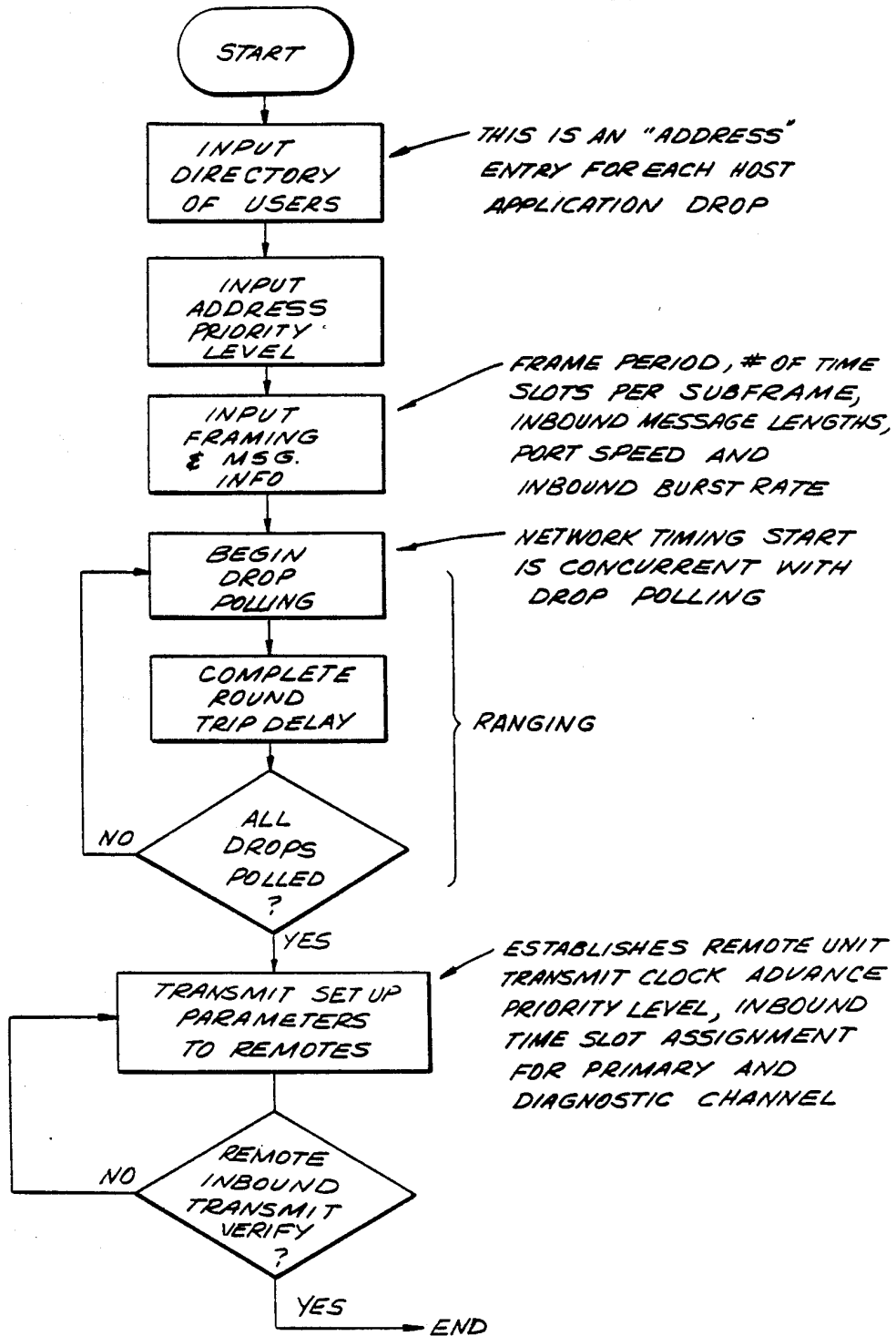
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FIG. 6



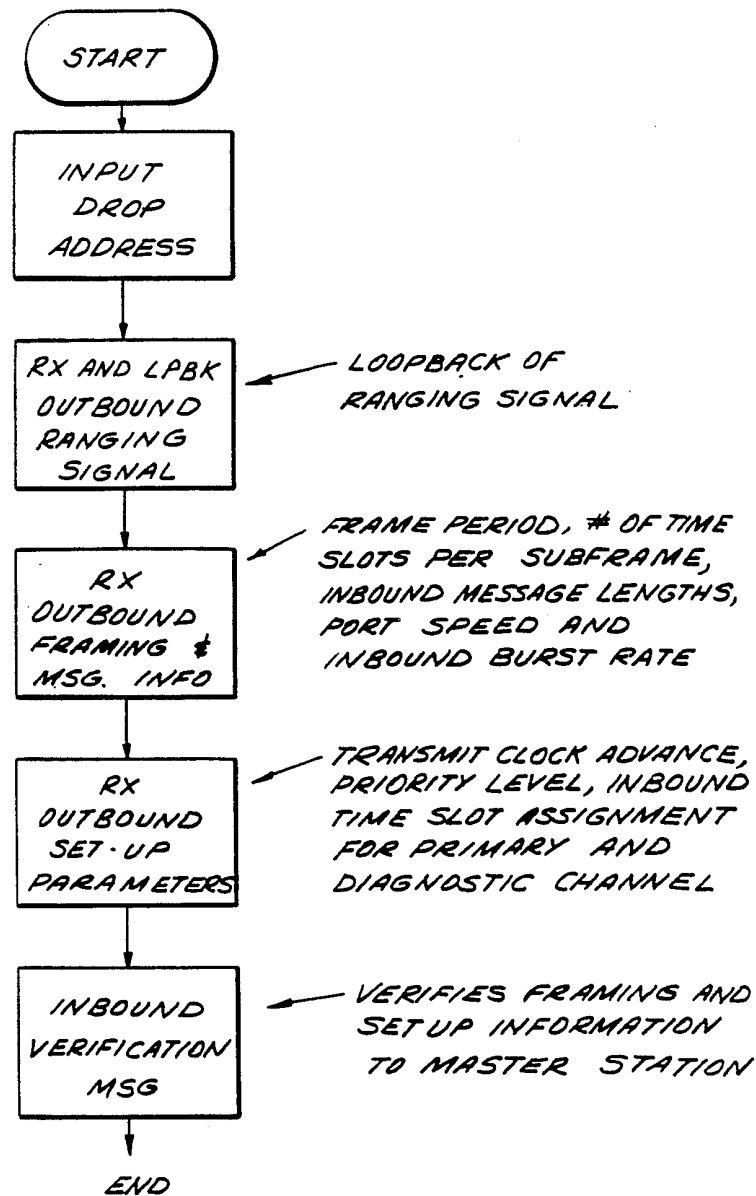
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FIG. 7



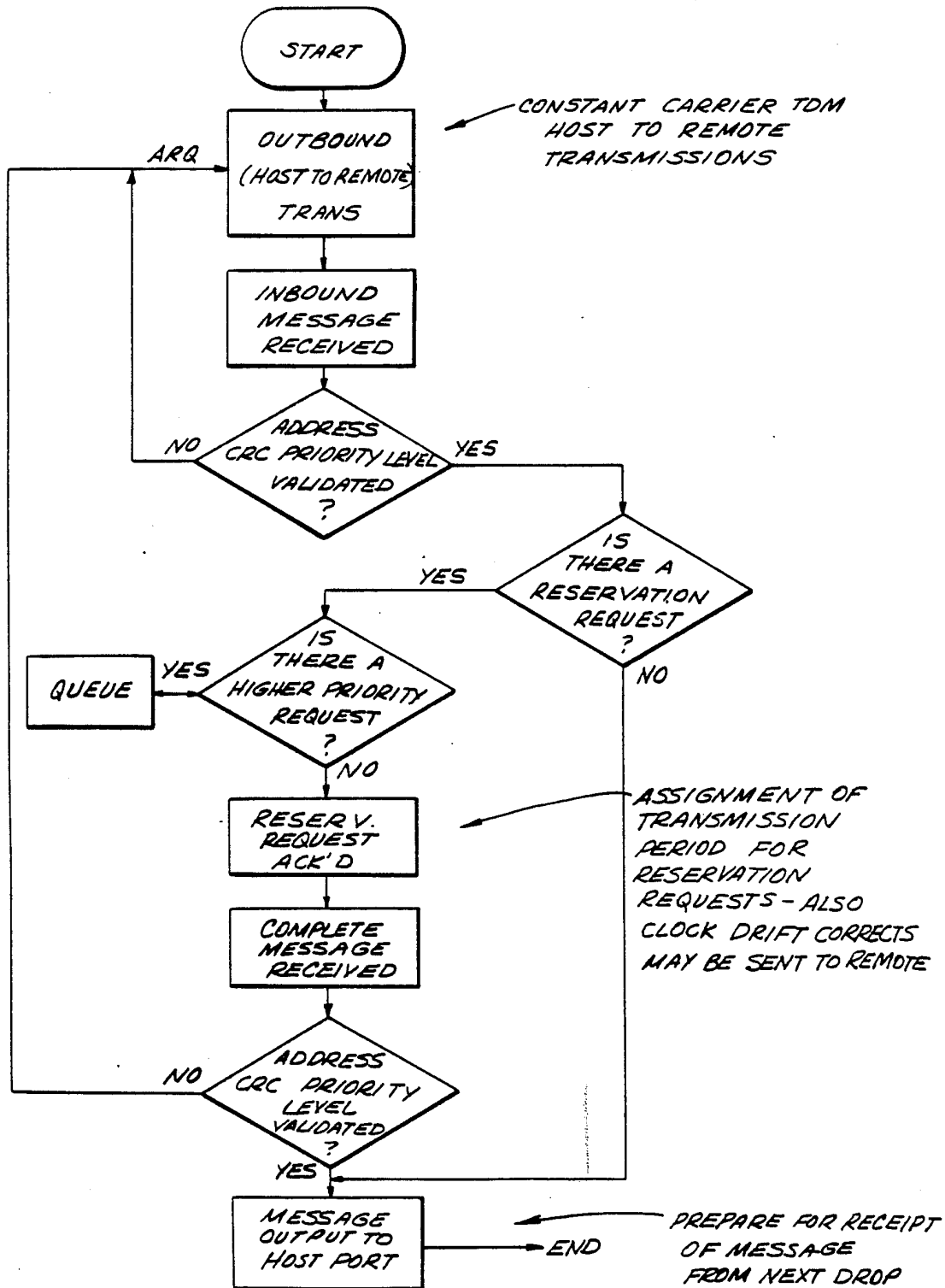
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FIG. 8



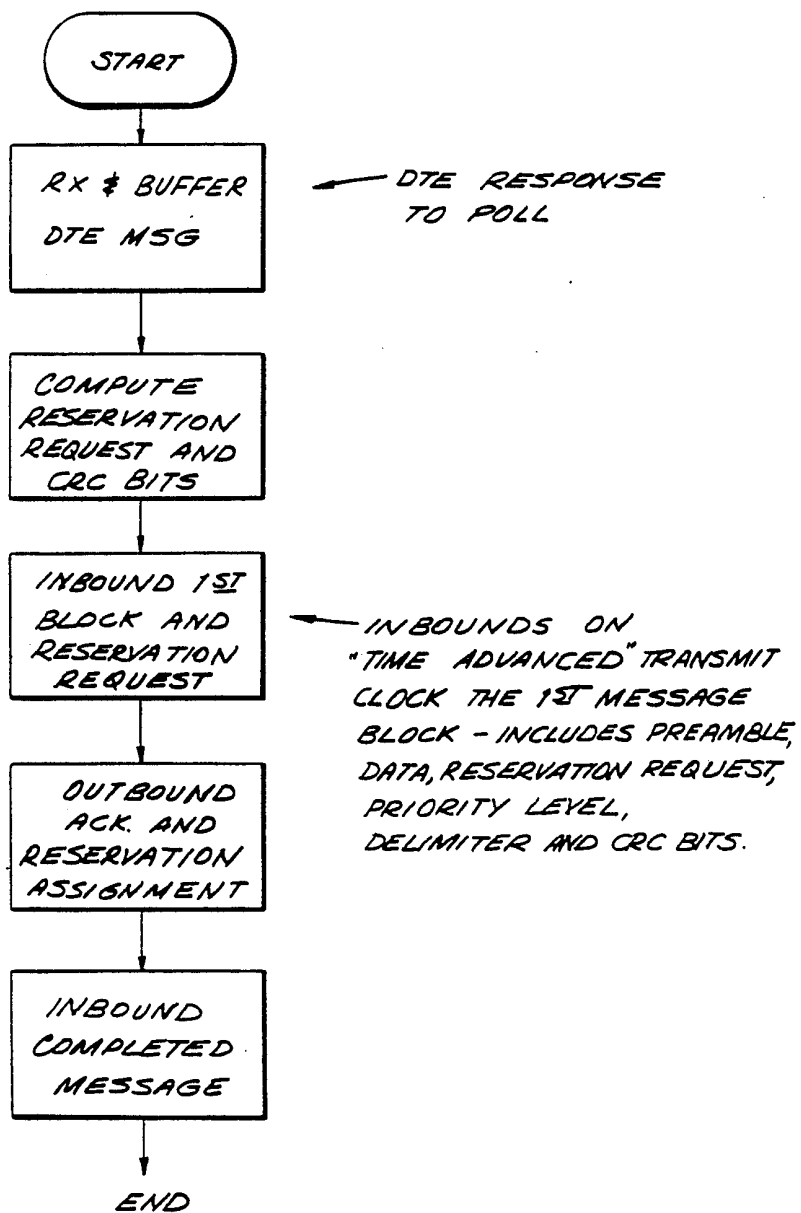
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FIG. 9



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TIME ORTHOGONAL MULTIPLE VIRTUAL DCE FOR USE IN ANALOG AND DIGITAL NETWORKS

BACKGROUND OF INVENTION

1. Field of Invention

This invention relates to an apparatus and method for a master unit in a multidrop network to communicate to and from a plurality of remote units, using a plurality of host applications using half duplex polled protocols, through the use of time division multiple access techniques.

2. Scope of the Prior Art

In the prior art, in order to run multiple host applications to multiple modems in a multidrop network, it is common to use a single network channel for each application, thereby effectively resulting in a number of networks rather than a single network. Further, such an arrangement is clearly an inefficient use of leased lines and other equipment.

A common solution to this deficiency of the prior art is to use a single line with frequency division multiplexing. That is, a number of orthogonal carrier frequencies, one for each application, are transmitted over a single line to a plurality of remote units in a multidrop network. However, with such apparatus, the non-linearities of the communications line (most frequently, a telephone line), interfere with the co-existence of multiple carrier frequencies. This interference includes intermodulation, cross-modulation and spillover between and among channels. Furthermore, a strong signal on one carrier frequency could suppress a weak signal on another carrier frequency.

Due to this interference, time-consuming engineering adjustment is required to install and maintain such a system. Such interference increases with an increasing number of co-existing carrier frequencies, thereby limiting the number of carrier frequencies which could be practically carried on a single line. For practical applications, no more than three carrier frequencies can be carried simultaneously on a telephone line.

OBJECTS AND SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide a method and apparatus for allowing a single multidrop network to run multiple applications to multiple remote units.

It is therefore a further object of this invention to provide such a method and apparatus without a fundamental limitation on the number of applications which can be implemented.

It is therefore a further object of this invention to reduce the amount of engineering adjustment needed to install and maintain such a method and apparatus.

The present method and apparatus permits multiple multidrop networks (such as Dataphone Digital Service for digital applications or conventional telephone company lines for analog applications), each serving a distinct half-duplex host polled application, to be replaced by a single multidrop network serving each of said host applications.

The basic features of this method and apparatus are time division multiplexed outbound transmissions from the master to the remote units for data and control; time division multiple access transmissions inbound from the remote units to the master unit; master to remote ranging with respect to transmission time; and priority as-

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signed reservation request for long poll responses. A channel rate exceeding the aggregate port rate is required in order to transmit effectively all of the information from the remote units and allow for control format messages. All remote units (or "drops") receive messages outbound from the control unit and respond in a unique time period assigned to each host application. Contention between applications is thereby avoided due to the fact that each application is assigned such a unique time period. By ranging or measuring the round-trip transmission or delay time between the master unit and each remote unit, and storing these times in a table so as to accurately synchronize the transmissions in a time division multiple access mode, the "guard time" separating inbound transmissions from interfering with each other can be minimized thereby increasing system efficiency.

In order to accommodate longer message lengths from a remote unit to the master unit, a remote unit can append a request for additional time onto its message to the master unit. The master unit will then compare the priority of the requesting remote unit to the priority of subsequent units and make a decision as to whether to allow the requesting remote unit to use the time division multiple access slots of subsequent units.

By the use of the foregoing, a user can install several host applications employing half duplex polling on a single multidrop network, without a fundamental limit on the number of applications and without the need for extensive engineering adjustment during the installation and maintenance of the system. This allows an end user to have fewer modems or data service units/channel service units (DSU/CSU) on the customer premises.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. I shows a block diagram of the master unit in the digital application of this invention.

FIG. II shows a block diagram of the remote unit in the digital application of this invention.

FIG. III shows a block diagram of the master unit in the analog application of this invention.

FIG. IV shows a block diagram of the remote unit in the analog application of this invention.

FIG. V shows a schematic of a subframe format.

FIG. VI shows a flow diagram of the initialization of the master unit.

FIG. VII shows a flow diagram of the initialization of the remote unit.

FIG. VIII shows a flow diagram of the normal operation of the master unit.

FIG. IX shows a flow diagram of the normal operation of the remote unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in detail wherein like numerals refer to like elements throughout the several views, master unit 10 for digital applications is shown in FIG. I. Master unit 10 includes a network timing and control processor 12. Network timing and control processor 12 uses firmware or software to implement clock drift reset functions, guard time predict functions, burst receiver control functions, reservation assignment functions, cyclic redundancy check (crc) "checksum" calculations, arq functions, remote transmit control functions and user library update functions such as activity rate and frame parameters. Additionally, network timing

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and control processor 12 stores user-input initialization parameters including network clock framing periods, slot and subframe assignments, inbound and outbound burst length for each "drop" or remote unit, priority assignments, drop addressing, and port speed assignments.

Reservation request processor 14 allows a drop or remote unit to request more than a single time slot for longer messages. Reservation request processor 14 communicates such a granted request to the network timing and control processor 12.

The aggregate rate multiplexing module 16, in response to commands from the network timing and control processor 12, sets up the timing and bit interleaving of the various application inputs from the various input ports of the primary channel multiplexer 18 and of the overhead and control bits required for outbound control of the remote units from the ranging and network initialization generator 20. The output of the aggregate rate multiplexer 16 is input to the time division multiplexed modulator 22 which transmits the data to the various drops or remote units (see FIG. II). The time division multiplexed modulator 22 is typically a baseband modulator for digital applications.

The master unit 10 also provides, in addition to primary traffic flow over the channel outbound to remote units, a diagnostic channel which can be inbound, and any control information necessary to update clock drifts, perform new ranging, etc.

The input in the form of noncontending packets or bursts of information from the various drops or remote units is received via a single data channel by equalizer 24. The input stream has its gain automatically adjusted 26 and is demodulated by demodulator 28.

Demodulator 28 provides digital data to the expansion buffers 30, the ranging receiver 32, the reservation request processor 14 and the bit/ baud timing processor 34.

The expansion buffers 30 output digital data to the data port outputs of the various applications and a diagnostic channel via the port demultiplexer 36.

The ranging receiver 32 receives data from the demodulator 28 during an initial training period (to be described later) so as to store round trip transmission times to each remote unit. This allows an optimization in synchronization of the time division multiple access process, thereby reducing "guard time" between the reception of data from the various remote units thereby increasing the total data transfer rate of the system.

Referring now to FIG. II, data outbound from the time division multiplexed modulator 22 of FIG. I is received by the demodulator 38 of remote unit 40. The output of demodulator 38 is demultiplexed by demultiplexer 42 which, in turn, feeds the primary data receiver ports and any diagnostic or secondary channel required by the particular application. The demodulator 38 also provides bits to the network initialization parameter extraction module 44 and the timing and control block 46. Network initialization parameter extraction module 44 and timing and control block 46 provide the user with network timing extraction information, the slot assignment in which the user is allowed to operate and any control information such as transmit inhibit, transmit enable, reservation grants and other network control provided by the master unit (see FIG. I). Additionally, the ranging calculations, that is, the master unit calculation of the time a signal takes to go from the master unit to any remote unit and vice versa, is stored

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in the timing and control block 46 where it is used for time advancing the transmit clock.

The timing and control block 46 supplies control bits to compression buffers 48. The timing and control block 46 also feeds the preamble and cyclic redundancy check ("checksum") module 50 and the modulator 52. Additionally, the timing and control block 46 sets up the reservation request generator 54. Reservation request generator 54 monitors the compression buffer for fields exceeding a preset parameter limit which is stored in the initialization parameter table. If a field length exceeding the parameter is sensed, then reservation request generator 54 automatically sets the reservation bits in the outgoing message. The format of the outgoing message, including reservation bits, crc bits, message traffic and preambles are described later herein.

Modulator 52 outputs messages via the communication lines to equalizer 24 of the master unit (see FIG. I).

FIG. III discloses the analog version of the master unit. FIG. I is identical to FIG. III except for the addition of the automatic gain control/equalizer tap store function which is added to ranging receiver 32 so as to provide operating parameters to the burst equalizer 24 and the burst automatic gain control 26 dependent upon the particular remote unit which is transmitting to the master unit. Furthermore, as data is transmitted in "bursts" from the remote unit in the analog mode, such elements as the demodulator, agc, and equalizer in the master unit are entitled "burst demodulators", "burst agc", and "burst equalizer" respectively in the master unit. Similarly, the analog modulator in the remote unit is entitled "burst modulator" (FIG. IV).

This is due to the fact that, in the preferred embodiment, the analog mode requires a true burst mode of operation whereas in the digital case, the burst mode requirement is eliminated due to the presence of a constant envelope baseband which includes idle codes when data is not being transmitted.

It should be noted here that the digital application, for instance, one using Dataphone Digital Service, has an inherent advantage over the analog counterpart, and is therefore a slightly preferred embodiment, in that the inbound traffic received at the master unit is a continuous transmission. That is, either information or idle codes are always being transmitted. There are no periods when the signal is not present. As a result, the number of overhead bits required in each remote transmission in the digital application is considerably reduced. This combined with the high channel to port speed ratio permits lower delay penalties. This results in a greater efficiency in the digital system as compared with the analog system.

The time division multiple access sequence is established by the user. An epoch period or frame is defined by the user. The frame is divided with respect to time into a number of subframes. The subframe is further subdivided into slots, one for each application. Therefore, an application has a preassigned time period (or slot) within a subframe to transmit from the remote unit to the master unit, with the possibility of a reservation request for longer messages.

FIG. V discloses a typical subframe. A subframe is divided into N time slots, each separated by a guard time. Each slot contains a preamble, message bits, reservation request bits, priority bits, and error detection bits. The reservation and priority bits may be replaced by address bits. For example, five bits would permit up to 32 drops. The address bits would be an identifier to

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the master. The master could then monitor remote clock accuracy, monitor drop transmission events, perform ranging, etc.

Due to the number of total bits exceeding the number of message bits, the aggregate burst (in the case of analog) or transmission (in the case of digital) rate must be higher than the sum of the independent port rates.

As part of the installation of this device, both the master and remote units must be initialized.

As is disclosed in FIG. VI, the first step in the initialization of the master unit is to input the directory of users. This is an address entry for each host application drop.

The next step is to input the address priority level. This is followed by an initialization of such system parameters as frame period, number of time slots per subframe, inbound message lengths, inbound and outbound transmission rates (notice that aggregate burst rate must be higher than the sum of the independent port rates so as to accommodate individual ports along with associated overhead), priority assignments, drop addressing and, port speed assignments. This information is stored in the network timing and control processor.

The initialization phase of operation also includes a ranging calculation for each combination of remote unit (or "drop") and application. The master unit sends a message which makes a round-trip between the master unit and the individual remote unit. The delay period is stored in a library table in the network timing and control processor 12 so that the remote to master unit communication is synchronized, thereby reducing guard time required between successive transmissions and increasing the efficiency of the system.

Additionally, in the case of analog apparatus, the signals received by the master unit during the ranging calculation are used to train the automatic gain control 26 and the equalizer 24, thereby generating an automatic gain control/equalizer tap store function.

Finally, "set-up" parameters are transmitted from the master unit to the remote units so as to establish remote unit transmit clock advances, priority level, and inbound time slot assignments for the primary and diagnostic channels. The remote unit verifies receipt to the master unit.

Initialization of the remote drops is disclosed in FIG. VII. The user inputs the address of the drop or remote unit. The remote unit returns or "loops-back" the ranging signal from the master unit. The remote unit receives the frame period, the number of time slots per subframe, inbound message lengths, port speed and inbound burst (digital) or transmission (analog) rate.

The remote unit receives set-up parameters such as clock advance, priority level and inbound time slot assignment for the primary and diagnostic framing and set-up information to the master unit.

A flow diagram of the normal operation of the master unit is shown in FIG. VIII.

The master unit sends a message to one of the remote units. An inbound message is received from one of the remote units. The address, cyclic redundancy calculation (i.e. checksum) and priority level are checked. If any of these values are invalid, the master unit retransmits to the remote unit. If these values are valid and there is no reservation request, the message is output to the appropriate application host port at the master end. This process is continually repeated for each application in each remote unit.

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If the aforementioned values are valid but there is a reservation request, then the message is queued in the event that there is a higher priority request or acknowledged and completely received in the event that there is no higher priority request. After the complete message is received, its address, checksum and priority are validated. If these values are valid, the message is output to the host port. If the values are not valid, the initial step of an outbound transmission from the master to the remote is returned.

FIG. IX discloses the normal operation of a drop or remote unit. The remote unit receives and buffers a DTE poll response message. The remote unit computes the reservation request and the CRC (cyclic redundancy check or checksum) bits. The CRC bits provide error detection for both overhead and transmit port primary data bits. The remote unit transmits the first block of data, and possibly a reservation request on the inbound channel at a predetermined time in accordance with the "time advanced" (to allow for transmission time and synchronize so as to reduce guard time) transmit clock. This block of data includes preamble data, reservation request, priority level, delimiter and CRC bits.

From the foregoing, it is seen that this system includes the following features:

1. The master to remote (outbound) transmission is a constant carrier time division multiplexed bit stream in which multiple Host/FEP poll and data traffic is bit interleaved along with master to remote network timing control and diagnostic information.

2. The master unit periodically transmits a network clock reading to all remotes and performs a roundtrip delay transmission calculation ("ranging") to each remote unit. The master unit informs each remote unit of its precise round trip value.

3. The period of the master network clock transmission establishes a "frame". This frame is further segmented into subframes at the remote.

4. The remote establishes a receive clock reference (a delayed version of the Master Network Clock) and a transmit clock reference.

5. For analog applications, the remote sends a long train to the master and the master trains and stores equalization taps and automatic gain control settings unique to the drop. This is unnecessary for digital networks due to the continuous presence of traffic (either idle codes or data).

6. The master unit preassigns time slots within the subframes, one for each of the independent host applications.

7. Upon receiving a poll at the remote DTE, RTS/CTS toggles and the DTE response bits are loaded into a buffer. The remote then transmits these bits in the assigned time slot using the transmit clock reference. Therefore, contention due to inbound poll responses from other remotes is precluded. All inbound transmissions contain a preamble, poll response data bits, reservation request bits, at least one priority bit and error detection bits. In the case of analog networks, the preamble is unique to the remote and enables the master to rapidly set the equalization taps and automatic gain control.

8. All inbound transmissions are at burst rates exceeding the remote port rate.

9. The subframe time slot is sized for the dominant poll response message length for the application. For longer transmissions, the remote unit sets the reserva-

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tion bits to identify the required number of additional time slots. The priority bit or bits define the remote's relative importance in reducing poll-response delays. The master unit clocks the received message bits to the expansion buffer 30 and checks the reservation and priority bits for error. If no errors are detected, the master responds to the remote with an "authorization to transmit" command and transmits a "transmit inhibit" command to all of the other remote units. Each of these outbound transmissions are error protected so that remote transmission contention is extremely unlikely. The authorized remote commences transmission on the next available time slot and continues until the message transmission has been completed. During this period the expansion buffer clocks data bits to the host.

10. The master unit can recognize whether a remote clock is drifting and so inform the remote with a fast or slow correction value. Such information can be extracted from the actual time of arrival compared with the expected time of arrival at the master unit and the preamble which identifies the transmitted remote.

11. Analysis diagnostic related information is bit interleaved onto the outbound transmission. Because of the relatively slow poll rate of the Analysis system, the inbound response may be assigned to time slot in every Nth subframe. Thus, the aforementioned goals are achieved.

What is claimed is:

1. A communications network comprising:

a master unit;

a plurality of remote units communicating with said master unit in a multidrop configuration;

wherein each of said remote units execute at least one application program, at least one of said remote units executing at least two application programs, said remote units receiving messages outbound from said master unit and responding in a time slot assigned to each of said application programs;

said master unit including a master network timing means with a period which is divided into a plurality of subframes, wherein each subframe is divided into said time slots, and each of said time slots is used as an interval in which one of said application programs in said one of said remote units is assigned to transmit to said master unit in a time division multiple access fashion; and

said master unit including ranging means communicating with said master network timing means wherein a transmission time between said master unit and each of said respective remote units is calculated and transmitted from said master unit to each of said respective remote units, each of said respective remote units using said transmission time to adjust initiation of said time slots.

2. The network of claim 1 wherein said remote units include a reservation request generator which activates a reservation request bit for requesting an additional time interval inbound to said master unit, and wherein said master unit includes a reservation request processor communicating to said master network timing means, said reservation request processor being responsive to said reservation request bit.

3. The network of claim 2 wherein said master unit initiates communication with said remotes using half duplex polled protocols.

4. The network of claim 3 wherein communication from said remote units to said master unit is in the form of modulated bursts on an analog carrier frequency.

5. The network of claim 4 wherein communication from said remote units is received by a burst equalizer in series with a burst automatic gain control in said master unit, said burst equalizer and said burst automatic gain

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control being responsive to operating parameters which are dependent upon which of said remote units is scheduled to transmit.

6. The network of claim 5 wherein said operating parameters are calculated in an initial training period and stored in said master unit.

7. The network of claim 6 wherein said operating parameters are indexed in said master unit and advanced from said master unit to said burst equalizer and said automatic gain control in response to a preamble unique to each of said remote units which is communicated from said remote units to said master unit.

8. The network of claim 3 wherein communication from said remote units to said master units is in digital form.

9. The network of claim 8 wherein communication between said remote units and said master unit is encoded using baseband modulation.

10. The network of claim 3 wherein said master unit includes a master network clock with a period which is divided into a plurality of subframes, each corresponding to transmission time for one of said remote units, and wherein each subframe is divided into said time slots, and each of said time slots is used as an interval in which one of said applications programs in said one of said remote units transmits to said master unit.

11. The network of claim 2 wherein said time slot comprises a format so as to include a preamble, a poll response data bit, said reservation request bits, at least one priority bit and error detection bit.

12. The network of claim 1 wherein the master unit includes means for calculating clock drifts of the remote units and issuing reset commands to correct the same whereby each remote unit determines its transmit epoch accurately, thereby minimizing guard time while maintaining contention-free transmission to said master unit, said means for calculating clock drifts and issuing reset commands being in communication with said master network timing means.

13. The network of claim 4 wherein said bursts occur at a burst rate which is greater than an aggregate port rate of said remote units.

14. A method for a plurality of remote units to operate a plurality of application programs in communication with a master unit in a multidrop configuration, comprising the steps of:

calculating and storing in said master unit inbound and outbound transmission times between the master unit and said remote units;

dividing a period of a clock in said master unit into a number of subframes, dividing each subframe into a number of slots, each corresponding to transmission times for one of said remote units, and assigning a slot to each of said application programs in said one of said remote units;

transmitting from said master unit to each of said respective remote units the transmission time between said master unit and said respective remote unit, each of said respective remote units using said transmission time to adjust initiation of said slots; and

transmitting data from each of said remote units to said master unit in a time division multiple access configuration wherein each application in each remote unit transmits during said assigned sub-frame.

15. The method of claim 14 further comprising the step of initiating communication between said master unit and said remote units by using half-duplex polled protocols.

* * * * *

Exhibit 3

United States Patent [19][11] **Patent Number:** **5,852,631****Scott**[45] **Date of Patent:** ***Dec. 22, 1998**[54] **SYSTEM AND METHOD FOR
ESTABLISHING LINK LAYER
PARAMETERS BASED ON PHYSICAL
LAYER MODULATION**

5,425,080	6/1995	Abbie	379/91.01
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[75] **Inventor:** **Robert Earl Scott**, Indian Rocks Beach, Fla.[73] **Assignee:** **Paradyne Corporation**, Largo, Fla.[*] **Notice:** The term of this patent shall not extend beyond the expiration date of Pat. No. 5,710,761.

Primary Examiner—Stephen Chin
Assistant Examiner—Jeffrey W. Gluck
Attorney, Agent, or Firm—Thomas, Kayden, Horstemeyer & Risley, L.L.P.

[57] **ABSTRACT**

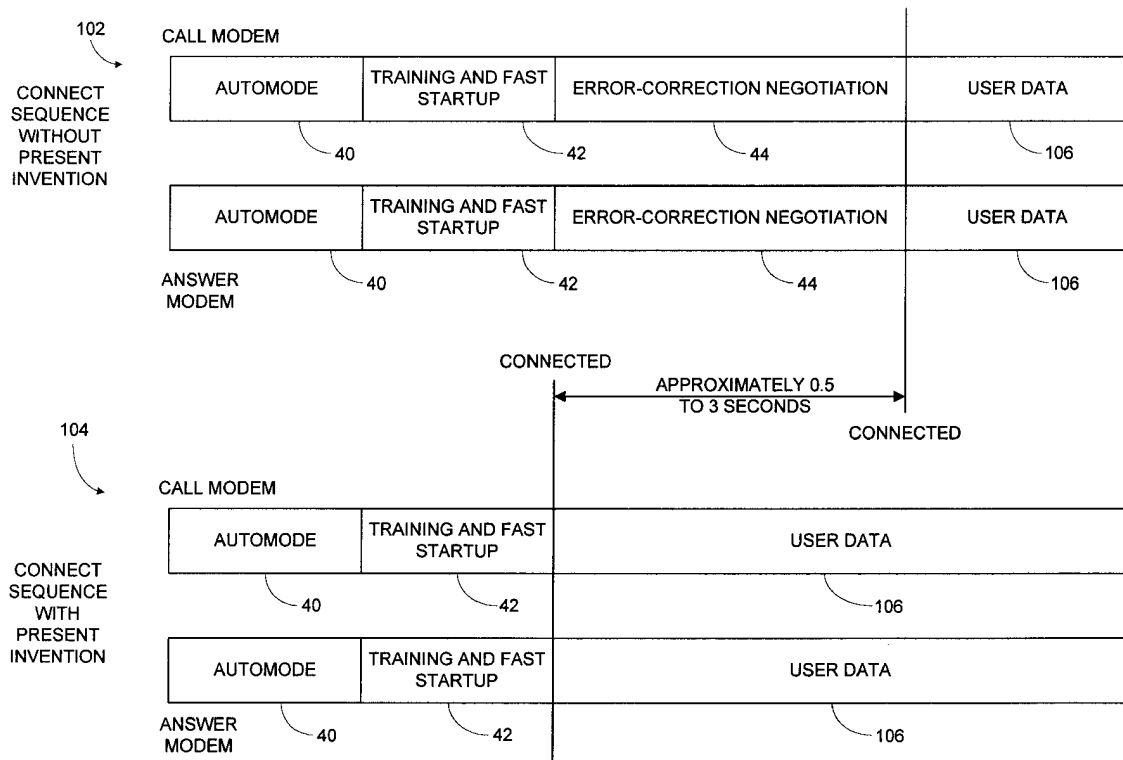
A system and method for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and one or more possible link layer connections and an answering modem having a plurality of possible second physical layer modulations and one or more possible link layer connections comprising the steps of establishing a physical layer connection between the calling and the answering modems, wherein the physical layer connection is based on a negotiated physical layer modulation chosen from the first and second physical layer modulations, and establishing link layer connection based upon said negotiated physical layer modulation. The link layer connection includes parameters that are preset to default values based upon the negotiated physical layer connection. Thus, the modems are able to avoid the link layer negotiation, thereby providing a faster and more robust connection.

[21] **Appl. No.:** **780,762**[22] **Filed:** **Jan. 8, 1997****Related U.S. Application Data**

[60] Provisional application No. 60/026,970, Sep. 20, 1996, and provisional application No. 60/022,474, Jun. 21, 1996.

[51] **Int. Cl.⁶** **H04L 29/10**[52] **U.S. Cl.** **375/222; 379/93.32**[58] **Field of Search** **375/222, 223; 379/93.29, 93.31, 93.32, 93.33, 120; 370/252**[56] **References Cited****U.S. PATENT DOCUMENTS**

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10 Claims, 8 Drawing Sheets

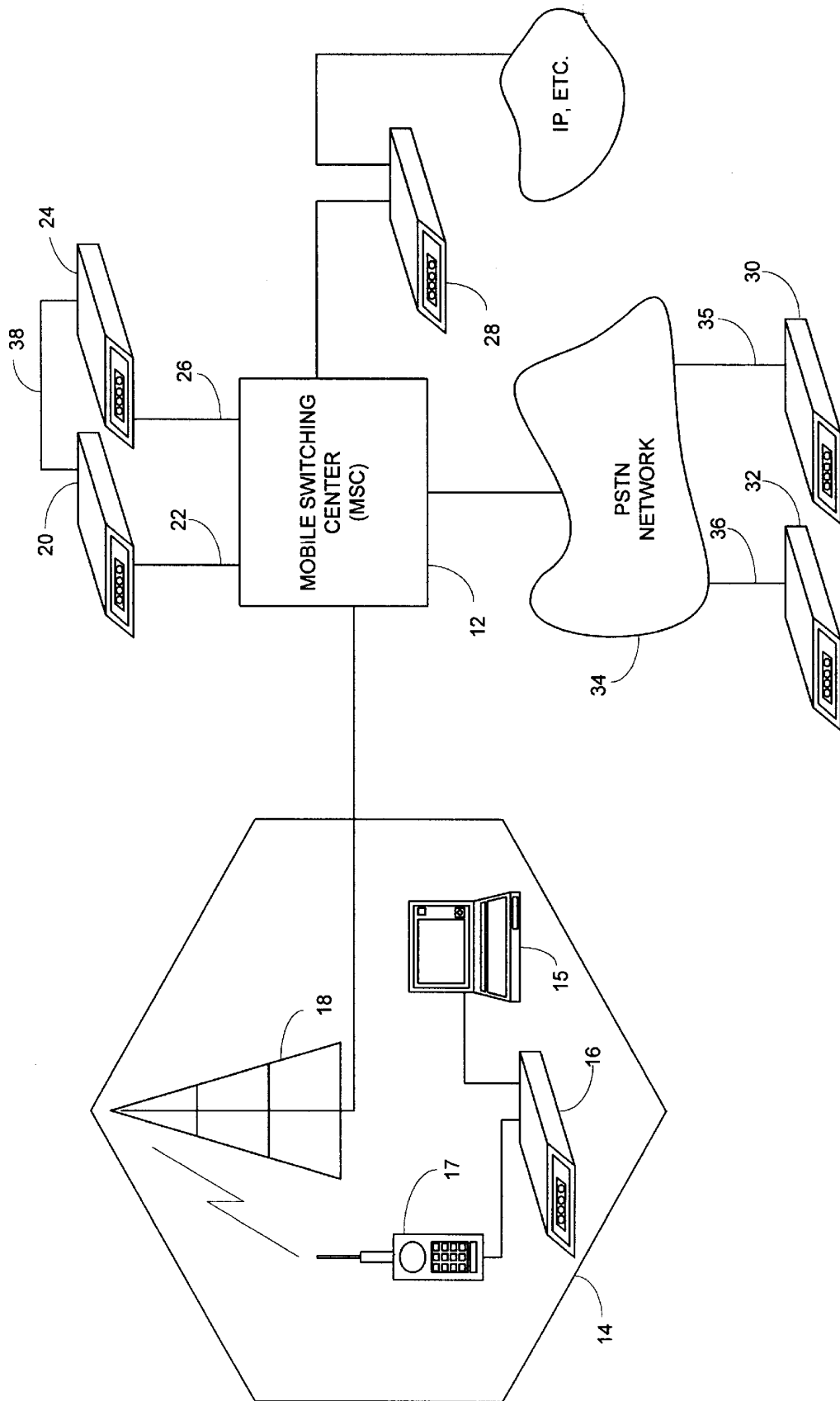


FIG. 1

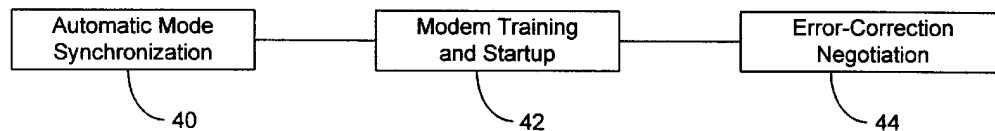


FIG. 2

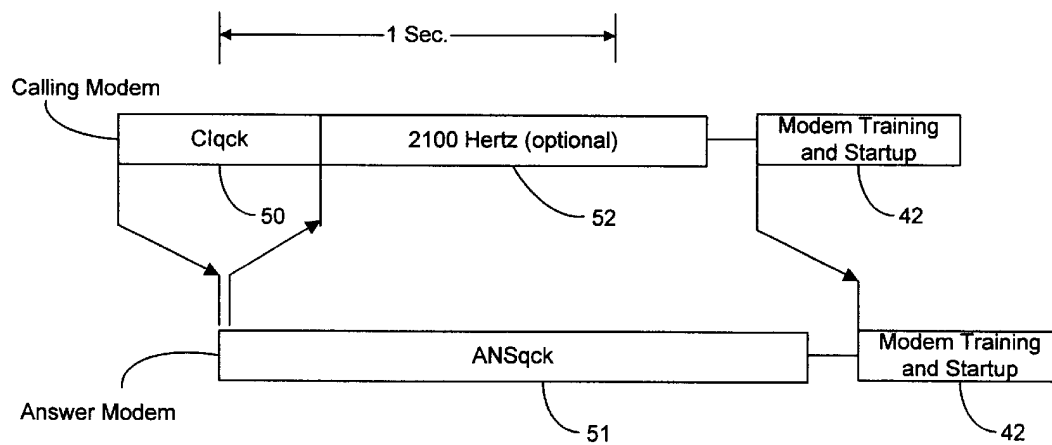
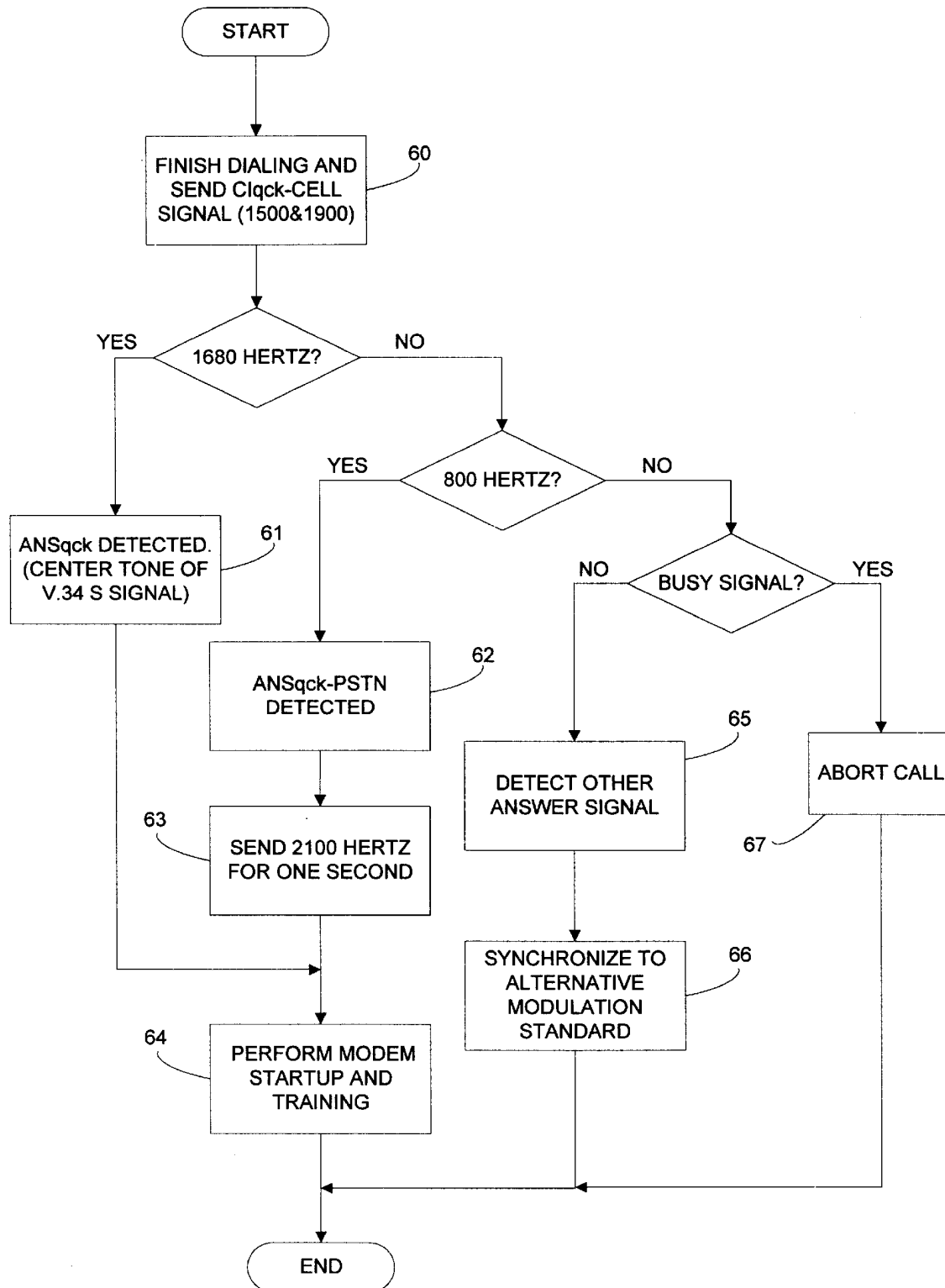
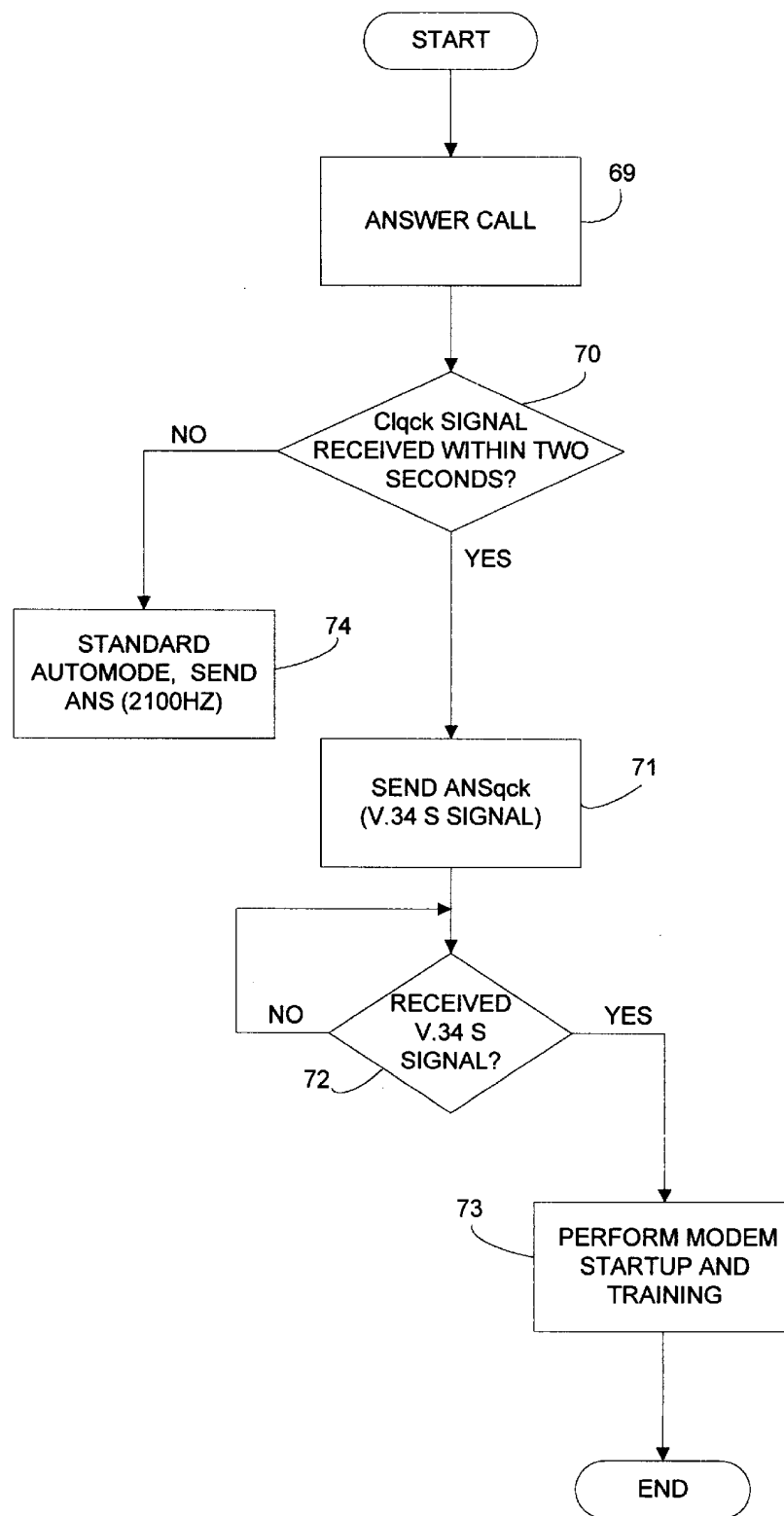


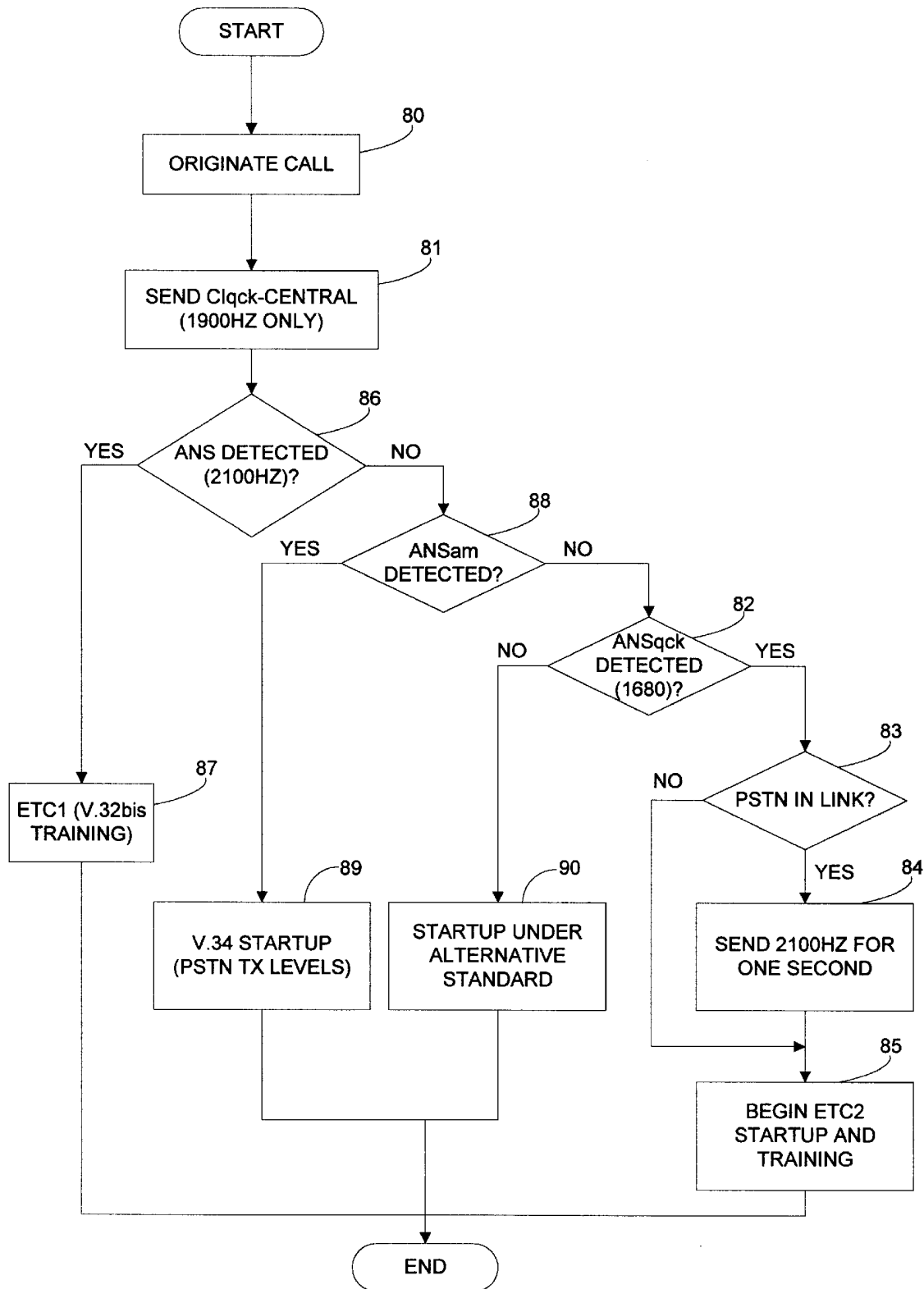
FIG. 3



Calling Modem -- Cellular
FIG. 4

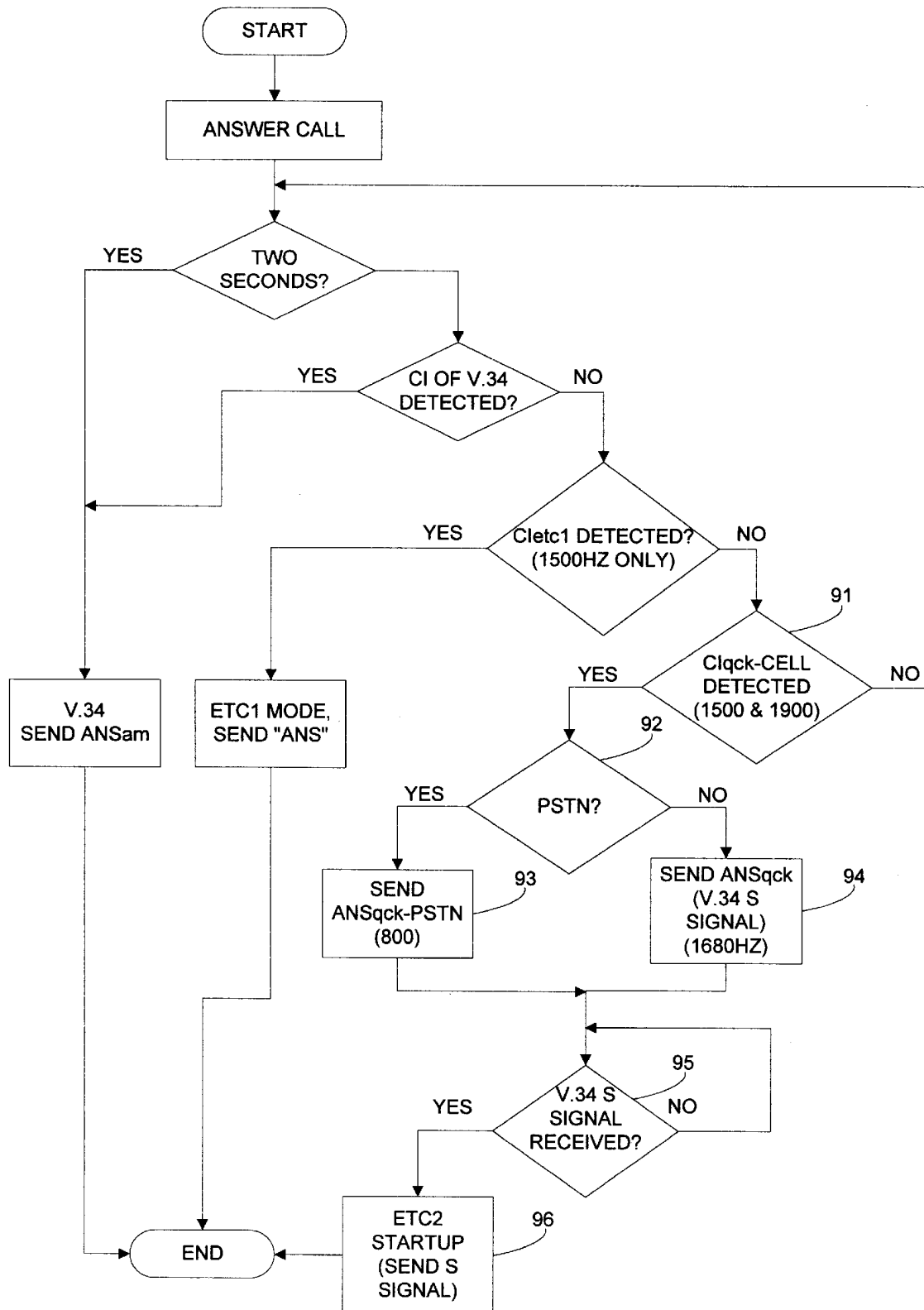


Answer Modem -- Cellular
FIG. 5



Calling Modem -- Central Site

FIG. 6



Answer Modem -- Central Site
FIG. 7

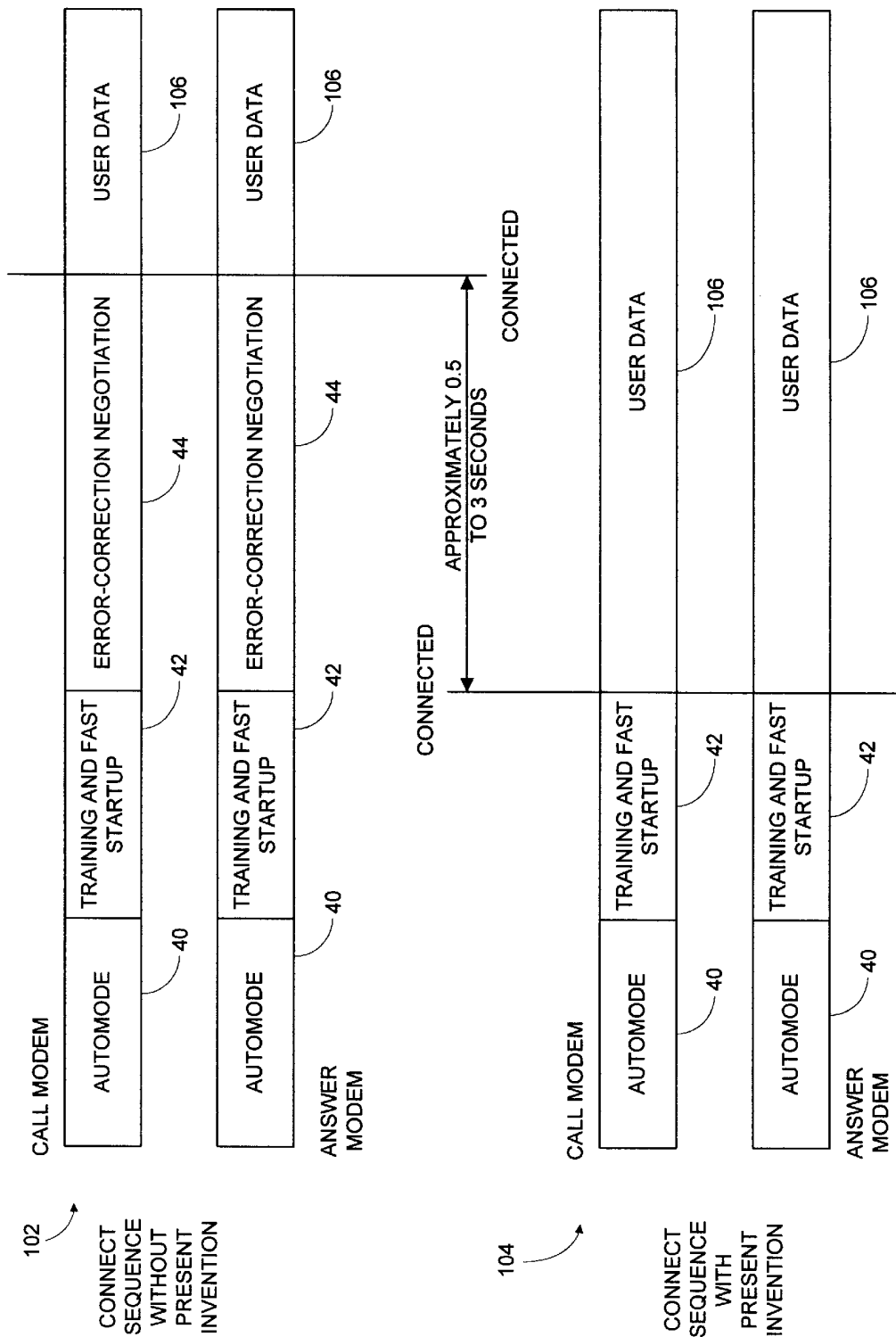


FIG. 8

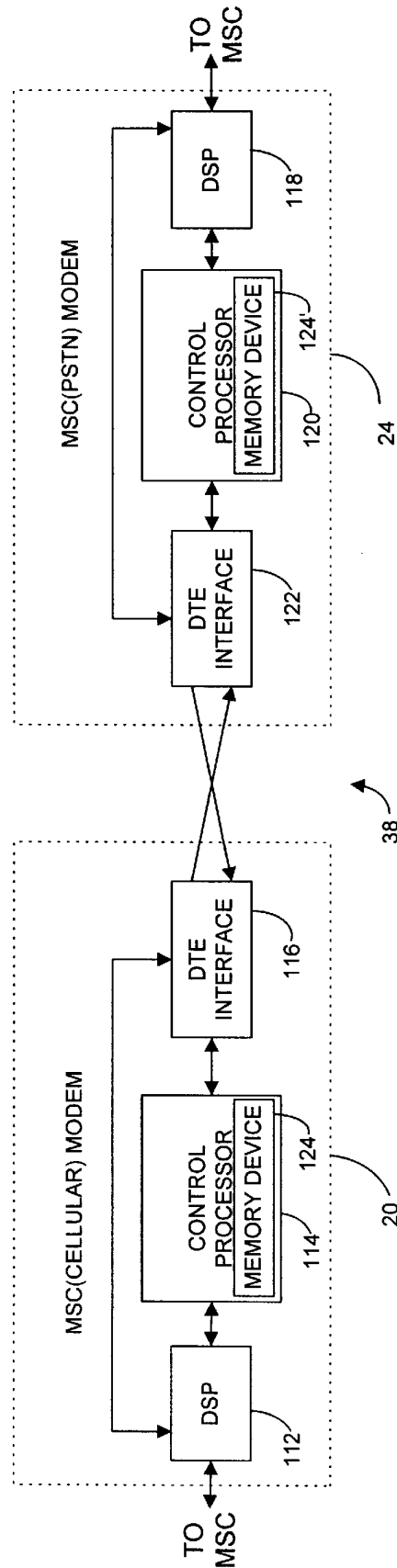


FIG. 9

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SYSTEM AND METHOD FOR ESTABLISHING LINK LAYER PARAMETERS BASED ON PHYSICAL LAYER MODULATION

This application claims priority to and the benefit of the filing date of copending and commonly assigned provisional application entitled CELLULAR DATA PROTOCOL FOR QUICK CONNECTION, assigned Ser. No. 60/026,970, and filed Sep. 20, 1996; and copending and commonly assigned provisional application entitled A RAPID START UP PROTOCOL FOR COMMUNICATION BETWEEN A PLURALITY OF MODEMS, assigned Ser. No. 60/022,474, and filed Jun. 21, 1996.

FIELD OF THE INVENTION

The present invention generally relates to data communication protocols, and more particularly, to presetting the link layer parameters per the physical layer modulation in a protocol stack for modems.

BACKGROUND OF THE INVENTION

In an effort to facilitate more reliable and platform independent communication links between remotely located computers, communication protocols are typically organized into individual layers or levels comprising a protocol stack. The lowest layer is designed to establish host-to-host communication between the hardware of different hosts. The highest layer, on the other hand, comprises user application programs which pass customer data back and forth across the communication link. Each layer is configured to use the layer beneath it and to provide services to the layer above it.

Examples of two protocol stacks are the Opened Systems Interconnect (OSI) seven layer model and the Transmission Control Protocol/Internet Protocol (TCP/IP) five layer model. The OSI seven layer model comprises the following layers from lowest to highest: a physical layer, a data link layer, a network layer, a transport layer, a session layer, a presentation layer, and an application layer. When combined, the seven layers form a protocol stack that is designed to provide a heterogeneous computer network architecture. The TCP/IP five layer model comprises the following layers from lowest to highest: a physical layer, a data link layer, a network layer, a transport layer, and an application layer. Of particular relevance to the present invention is the implementation of the physical layer and data link layer in these systems.

The physical layer of the OSI model is the lowest layer and is concerned with establishing the electrical and mechanical connection between two modems. The data link layer is the second lowest layer of the OSI seven layer model and is provided to perform error checking functions as well as retransmitting frames that are not received correctly.

As is well known, a variety of standards exist which govern the protocols for communication between modems. For example, V.21, V.22, V.32, V.32bis, V.34, V.42, and V.42bis, are identifiers of differing communication standards recommended by the International Telecommunications Union (ITU). Each one of these is directed to an aspect of either the physical layer or data link layer of the OSI model.

The ITU Standard V.34 (hereafter referred to as V.34) is intended for use in establishing a physical layer connection between two remotely located computers over the Public Switch Telecommunications Network (PSTN). The V.34 standard includes the following primary characteristics: (1) full and half-duplex modes of operation; (2) echo cancella-

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tion techniques for channel separation; (3) quadrature amplitude modulation for each channel with synchronous line transmission at selectable symbol rates; (4) synchronous primary channel data signaling rates ranging from 2,400 bits per second to 33,600 bits per second, in 2,400 bit-per-second increments; (5) trellis coding for all data signaling rates; and (6) exchange of rate sequences during start-up to establish the data signaling rate. The features of V.34 are documented in the publicly-available ITU Standard V.34 Specification and are well known by those skilled in the art, and will not be described in detail herein.

Another significant feature of V.34, as it relates to the present invention, is the ability to automode to other V-series modems that are supported by the ITU Standard V.32bis automode procedures. In this regard, V.34 defines signal handshaking that two connecting modems exchange at startup in order to learn the capabilities of the other modem to most efficiently exchange information.

While V.34 achieves efficient and generally high speed communication between two communicating modems, it nevertheless possesses several shortcomings that impede even more efficient operation. One significant shortcoming is the lengthy startup sequence which takes approximately 10-15 seconds. Particularly, for cellular customers, the ability to provide faster connections and faster data rates is particularly desirable since the cellular customer typically pays a charge for each cellular call based primarily on the length of the call and several other factors such as day of the week, time of day, roaming, etc. As a result, new fast connect protocols are being developed that provide for faster and more efficient startup operation based upon the system configuration and the path of the established communication link. An example of one such fast connect protocol is Paradyne Corporation's Enhanced Throughput Cellular 2 Quick Connect™ (ETC2-QC™). In essence, the ETC2-QC™ protocol uses techniques in the physical layer to reduce the physical layer startup time delay to about 1 second.

Of particular relevance to the present invention is the ITU Standard V.42 (hereinafter referred to as V.42). The V.42 standard is intended for use in establishing the error-correcting protocol of the data link layer connection. The V.42 standard includes a detection phase which determines whether both modems are capable of an error-corrected connection, an exchanging identification phase for determining error-correcting parameter values and a link establishment phase for establishing the error-corrected connection. Under normal circumstances, V.42 requires approximately 1-3 seconds to establish an error-corrected connection. While this is relatively small in comparison to the establishment of a physical layer connection under V.34, it can essentially double the connection time when used in conjunction with fast connect modems.

Therefore, a heretofore unaddressed need exists in the industry for a system and method that reduces or eliminates the time required to establish a link layer connection so as to minimize the amount of time for establishing a connection between two modems.

SUMMARY OF THE INVENTION

The present invention overcomes the inadequacies and inefficiencies of the prior art as discussed hereinbefore and well known in the industry. The present invention provides a system and method for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and a plurality of possible link

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layer connections and an answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections that comprises the following steps. One step includes establishing a physical layer connection between the calling and the answering modems, wherein the physical layer connection is based on a negotiated physical layer modulation chosen from the first and second physical layer modulations. Another step includes establishing a link layer connection based upon the negotiated physical layer modulation. This link layer connection includes parameters that are preset to default values based upon the negotiated physical layer connection. Thus, the modems are able to avoid the link layer negotiation that essentially all other modems perform, thereby providing a faster and more robust connection.

Other features and advantages of the present invention will become apparent to one with skill in the art upon examination of the following drawings and detailed description. It is intended that all such additional features and advantages be included herein within the scope of the present invention, as defined by the claims.

DESCRIPTION OF THE DRAWINGS

The present invention can be better understood with reference to the following drawings. The elements of the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present invention. Furthermore, like referenced numerals designate corresponding parts throughout the several views.

FIG. 1 is a system diagram, illustrating a multi-modem system, wherein a plurality of modems are interconnected among a plurality of communication links;

FIG. 2 is a diagram illustrating the primary handshaking and data exchange sequences between a calling and an answer modem;

FIG. 3 is a timing diagram similar to FIG. 2, illustrating the signal exchange during the automatic mode synchronization sequence of FIG. 2;

FIG. 4 is a software flowchart illustrating the operation of the present invention when the calling modem is a cellular modem;

FIG. 5 is a software flowchart illustrating the operation of the present invention when the answer modem is a cellular modem;

FIG. 6 is a software flowchart illustrating the operation of the present invention when the calling modem is a Central-site modem;

FIG. 7 is a software flowchart illustrating the operation of the present invention when the answer modem is a Central-site modem;

FIG. 8 is a schematic diagram comparing a first connect sequence of two fast connect modems with a conventional link layer connection and a second connect sequence of two fast connect modems with a link layer connection based on the physical layer negotiation in accordance with the present invention; and

FIG. 9 is a block diagram of the modems comprising a data gateway connected to the mobile switching center of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following description is of the best presently contemplated mode of carrying out the present invention. This

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description is not to be taken in a limiting sense, but is made merely for the purpose of describing the general principles of the invention. Consequently, the scope of the invention should be determined by referencing the appended claims.

The following description is divided into two parts. The first part discloses an example of a fast connect protocol for use in a modem system that is suitable for operating in conjunction with the present invention. It should be noted that the modem system disclosed in the first part is merely illustrative of a system that can benefit from the present invention, as will be evident to those of ordinary skill in the art upon reading the following disclosure. The second part discloses the present invention in the context of the fast connect modem system described in the first part. However, the present invention is equally well suited for application outside the context of the fast connect modem system described herein, for example, with modems that connect slowly.

I. Physical Layer Connection

Turning now to the drawings, FIG. 1 shows a system diagram of a system illustrating multiple modems intercommunicating through a variety of mediums, including cellular and PSTN. Indeed, as previously mentioned, a driving factor in the development of the present invention was to design a system that provided improved reliability in data communication over a data communication link. This goal has been achieved by removing the necessity to perform error-correction negotiation during the connect sequence in modem communication so as to reduce the overall connection time.

As illustrated, a cellular modem system may be disposed for communication with a mobile switching center (MSC) 12. More specifically, a cell 14 includes a portable computer 15 that is connected via a cellular modem 16 to a cellular phone 17, which in turn communicates (wirelessly) with a cell tower 18 that communicates with the MSC 12. It is appreciated that the modem 16 recognizes that it is on the cellular side via a strap or configuration setting, or alternatively by a direct connect sensing of the cellular phone. Therefore, and as will be discussed in more detail below, the modem 16 will know that it is capable of communicating in accordance with a modulation standard capable of performing a fast connect sequence as described below.

The MSC 12 is also connected to a data gateway comprising modems 20 and 24. The modems 20 and 24 are illustrated as connected in a back-to-back configuration and communicating to the MSC 12 over links 22 and 26. As will be appreciated and discussed below, the links 22 and 26 will support different communication protocols, or different modulation standards. The modem pool provides a data gateway for interfacing data calls originating from the modem 16, and thereby, allows cellular specific protocols to be used over the wireless connection between modems 16 and 20, as described below.

By way of definition, a "Central-site" modem is one that is capable of supporting the modulation standard of the present invention, and is not connected to a cellular phone. In this regard, all central-site modems are connected via four-wire connections. Examples which are illustrated in FIG. 1 include a mobile switching center MSC(Cellular) modem 20, an MSC(PSTN) modem 24, an MSC(Single-ended) modem 28, and a PSTN(ETC2-QC™) modem 30—where an MSC modem is one that is connected at the mobile switching center 12. A significant distinction among these various types of modems relates to the startup sequence, which will differ slightly depending upon the type

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of central-site modem. Preferably, a hardware identifier, such as a DIP switch or a firmware option configurable at modem installation, defines the type of modem for purposes of the startup sequence.

In keeping with the description of FIG. 1, modem 20 is illustrated as an MSC(Cellular) modem that is connected in a back-to-back mode with modem 24, an MSC(PSTN) modem. Modem 20, therefore, is designed to support the ETC2-QC™ modulation protocol and simulate a cellular modem during the initial modem startup routine. Modem 28 is an MSC(Single-ended) modem that, although it may communicate with modems on the PSTN 34, will typically communicate only with cellular modems. Indeed, when communicating with cellular modems, the 2100 Hertz tone, which is typically inserted to disable echo cancellers, is preferably omitted. Advantageously, elimination of this tone achieves a faster and more desirable modem startup.

A PSTN(ETC2-QC™) modem 30 and a standard PSTN modem 32 are connected via PSTN 34 to the MSC 12. The modem 30 is connected to the PSTN 34 via a four-wire connection 35, and modem 32 via a two-wire connection 36. Consistent with the concepts and teachings of the present invention, the four-wire connection 35 facilitates the communication of modem 30 with the cellular modem 16, for example, in the ETC2-QC™ modulation standard. However, as will be appreciated by those of ordinary skill in the art, merely ensuring a four-wire connection 35 alone will not ensure proper system operation in accordance with the present invention. In this regard, such a four-wire connection 35 may nevertheless pass through a two-wire connection, and thus a hybrid converter circuit, at the central office. In this event, echo will be injected into the signal and the abbreviated modulation standard of the present invention may be compromised. There are, however, steps that may be taken to ensure proper operation of the invention. These include, (1) ordering a Direct Inward Dial connection and instructing the phone company to avoid a two-wire connection for that setup; (2) obtaining a direct T1 connection to the Interexchange Carrier (for example, a "1-800" number); and obtaining an ISDN PRI connection, as it will always support four-wire for both call origination and call answer.

By way of illustration, consider a call originated by the computer 15 and cellular modem 16 to the standard PSTN modem 32. The established communication link will pass through the cellular phone 17 to the cell tower 18, through the MSC 12, across link 22 to the MSC(Cellular) modem 20 and to the connected modem 24 via RS-232 connection 38, across link 26 and back through the MSC 12 to the PSTN 34, and ultimately across the two-wire link 36 to modem 32. As will become clear from the description that follows, the cellular modem 16 and the MSC(Cellular) modem 20 will connect and startup in accordance with the fast connect communication protocol described herein. However, since the established communication link that passes from modem 24 to modem 32 passes through a PSTN 34 and a hybrid converter, then the communication protocol of the present invention will not be adequately supported. Accordingly, the modems 24 and 32 will identify this situation and will connect and communicate using an alternative communication protocol supported by both modems and capable of effective transmission across the established link. In this regard, the overall communication link does not realize the fast connection.

Indeed, an aspect of the fast connect protocol described herein is the determination of whether both modems are compatible, in terms of communication protocol, and whether they are connected through a line that passes

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through a PSTN. If the modems are compatible and the established communication link is outside a PSTN (e.g., cellular to MSC) or is to a PSTN modem with a 4-wire connection that has been configured for supporting a fast connect protocol, then the modems may connect and begin their startup sequence. In this regard, the fast connect communication protocol is designed to be fast as well as robust, and is accomplished by the use of simple tones. The use of such simple tones facilitates the implementation of the automatic mode select to be in the modem's control processor rather than the digital signal processor (DSP) chip.

In addition to the fast connect protocol discussed in below, the fast connect protocol also includes several "fall-back" modulations. More particularly, the modem of the present invention will preferably include Paradyne Corporation's Enhanced Throughput Cellular 1™ (ETC1™), V.34, V.32bis, V.32, and V.22bis modulations. Thus, in the previous example, modems 24 and 32 may communicate using one of these communication protocols. These modulation protocols are documented and will be understood by persons of ordinary skill in the art, and will not be discussed herein. It suffices to say that supporting the above-listed modulation standards greatly enhances the flexibility and versatility of a fast connect modem.

To more particularly describe the initial startup sequence in accordance with the modulation standard of the fast connect modem, reference is made to FIGS. 2 and 3. FIG. 2 illustrates the three principal components of modem exchange or communication. After the cellular modem initiates the call, such that a communication link is established, the modems enter a mode select sequence, referred to herein as automatic mode synchronization 40. During this period, the modems exchange parameters that identify the modems, and thus, their communication protocol. This sequence 40, thus, synchronizes the modems for communication in accordance with the same standard or protocol, such as V.34, V.22, V.22bis, etc.

Once the modems have synchronized their communication protocol, or modulation standard, then they enter a training and startup sequence 42. In a manner known in the art, during this sequence the modems may test the established communication link for noise, bandwidth, etc., in order to determine an appropriate rate for communication. The modems may also operate during this period to train their internal echo cancellers by, for example, ranging the established link of communication. In accordance with a related aspect of the fast connect modems, under certain circumstances the modem training and startup sequence may also be significantly shortened to provide a more robust (both time-shortened and reliable) startup sequence. More particularly, the "circumstances" which provide such a robust startup include communicating modems constructed in accordance with the invention detecting an established link of communication that does not pass through any two-wire connections. The completion of this sequence signifies the establishment of a physical layer connection between two modems.

After the physical layer has been established, the communicating modems enter the information exchange/communication sequence, referred to herein as error-correction negotiation 44, in order to establish the link layer connection. This is of particular relevance to the present invention in that it includes negotiation of an error-correcting protocol such as V.42. During this sequence 44, the modems detect whether they are error-correcting modems and, if so, they negotiate the error-correcting parameters.

Referring now to FIG. 3, the initial automatic mode synchronization 40 is illustrated. As shown, this sequence is

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executed by exchanging signals between the calling modem and the answer modem. After the calling modem instructs the cellular phone to establish the communication link with the answer modem, it transmits the calling signal C1qck 50. As will be described in more detail in connection with the flowcharts of FIGS. 4-7, this signal may comprise a 1900 hertz tone, or alternatively may comprise a 1500 hertz tone modulated with a 1900 hertz tone. If only a 1900 hertz tone is transmitted as C1qck signal 50, then the answer modem knows that the calling modem is configured as a Central Site, four-wire modem (see FIG. 6). Alternatively, if the C1qck signal includes both 1500 and 1900 hertz components, then the answer modem knows that the calling modem is configured as a cellular modem.

As will be appreciated by those of ordinary skill in the art, other calling signals may be transmitted by the calling modem. For example, calling signals consistent with that of a facsimile transmission, or calling signals consistent with other modem modulation standards, such as V.34, V.32, V.32bis, etc., may be transmitted. Since automatic connection and synchronization to facsimile, and these other modulation standards, are well known it will not be discussed herein. Indeed, the significance of the fast connect protocol is achieved when both the calling modem and the answer modem are capable of communicating in accordance with the fast connect modulation protocol herein described so that through the exchange of tones, the modems are made aware of the possible shortcuts in the fast startup and training sequence 42, and more particularly, in the error-correction negotiation 44.

Once the C1qck signal 50 is received by the answer modem, then the answer modem transmits its response back to the calling modem. The purpose of this answer signal is not only to signal receipt of the calling signal, but also to uniquely identify the answer modem. Again, as is known in the art, this answer signal may comprise ANS or ANSam signals as are known by the V.34 and V.32bis communication protocols. If so, the calling modem will then startup and train 42 and perform error-correction negotiation 44. Significant to the present invention, however, is when the answer signal is ANSqck, which is defined by either a 1680 hertz tone or an 800 hertz tone.

As illustrated in FIG. 4 (assuming the calling modem is a cellular modem), if ANSqck is an 800 hertz tone, then the calling modem knows that the answer modem is configured as a four-wire connection, and can communicate with the calling modem in accordance with the fast connect communication protocol and, in accordance with the present invention, set the error-correction parameters to preset values so as to avoid the necessity of negotiating the parameters. In addition, the 800 hertz ANSqck signals the calling modem that the answer modem is connected to a PSTN 34 (see FIG. 1). Therefore, the calling modem transmits a 2100 hertz tone for approximately one second. This, as is known, serves to pad the initial two second connect period, as required by the FCC for billing purposes. Furthermore, it serves to disable the echo cancellers within the PSTN 34.

If ANSqck is a 1680 hertz tone, which is the center tone of V.34 S signal, then the calling modem knows that the answer modem is configured as a four-wire connection, and can again communicate with the calling modem in accordance with the fast connect communication protocol and, in accordance with the present invention, set the error-correction parameters to preset values so as to avoid the necessity of negotiating the parameters. More significantly, it tells the cellular calling modem that the answer modem is not connected to the PSTN 34. Therefore, both the calling

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modem and the answer modem can determine that the established communication link is entirely outside the PSTN 34. Accordingly, the Federal Communications Commission (FCC) billing delay need not be inserted. Furthermore, certain assumptions may be made in regard to bandwidth, or transmission quality. For example, the established communication link will not pass through echo cancellers, and as a result, the calling modem need not transmit the 2100 hertz tone. Instead, upon receiving the ANSqck answer signal, the calling modem may immediately enter the modem training and startup sequence 42.

As will be further appreciated by those of ordinary skill in the art, by making certain assumptions regarding the line quality of the established link, the modem training and startup sequence 42 may be shortened. For example, in the preferred embodiment, the system initiates communication by assuming a 9600 baud rate. It has been found that most cellular connections may transmit at this rate, and certain front-end savings may be realized by defaulting to this initial startup rate. Of course, this rate may be increased, or autorated upwardly, in accordance with methods known in the prior art, after the initial startup and training sequence 42 has been completed.

Referring back to FIG. 4, a top-level flowchart is shown, illustrating the automatic mode synchronization of a cellular calling modem constructed in accordance with the fast connect protocol disclosed herein. Once the calling modem has completed transmitting the dialing sequence, it transmits the C1qck signal, which for a cellular calling modem includes modulated 1500 and 1900 hz tones, as indicated in block 60. Once the calling signal has been transmitted, the calling modem will wait to receive the answer signal from the answer modem. In order to exchange data using the modified modulation standard of the present invention, the calling modem looks to receive one of two answer signals. The first valid answer signal is in 1680 hz tone, which is the center tone of the V.34 S signal, as indicated in block 61. This tone signals to the calling modem that the answer modem is not only compatible to transmit in the fast connect modified modulation standard, but further indicates that the answer modem is connected via four wire connections, and does not interconnect to a PSTN. Accordingly, since the calling modem is a cellular modem, then the established communication link does not pass through a PSTN and the initial two second FCC-required delay need not be inserted into the start-up sequence. Moreover, since the entire communication link is four wire, then the modems need not transmit the 2100 hz signal to disable echo cancellers.

A second valid answer signal is an 800 hz tone, as shown by block 62, which also indicates that the answer modem is connected via four wire, and therefore, can communicate in accordance with the fast connect modulation protocol. In addition, the 800 hz tone indicates that the answer modem is connected to a PSTN. Assuming, as previously discussed, that the requisite steps have been taken to ensure that the established communication link does not pass through a two wire connection, then certain savings or efficiencies can be gained during the modem start-up and training sequences (e.g., eliminate echo training since no hybrid circuits are present in the communication link). Nevertheless, the FCC-required delay must be inserted and, therefore, a 2100 hz tone is transmitted at block 63 by the calling modem for a duration of approximately one second. The amount of the 2100 hz tone will "pad" the total modem automode and startup time to two seconds. This ensures that no customer data is transferred in the first two seconds (which meets FCC requirements). Thereafter, calling modem proceeds with the modem training and start-up sequence at block 64.

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If neither of the foregoing answer signals are received, then the system operates to determine whether another valid answer signal has been transmitted from the answer modem. The step of block **65** broadly designates this function. It should be appreciated that well known answer signals such as ANS or ANSam may be transmitted by the answer modem and, if received, the calling modem may synchronize to the appropriate modulation standard, as indicated in block **66**. Although not separately designated in the figure, it should be further appreciated that if no valid answer signal is received by the calling modem within a given period of time, the calling modem will time out and abort the attempted communication. Also, and as illustrated at block **67**, the calling modem will abort the attempted communication if a busy signal is received.

FIG. **5** shows a top-level flowchart illustrating the operation of a cellular answer modem constructed in accordance with the fast connect communication protocol described herein. Once the communication link has been established and the call answered at block **69**, the answer modem looks to detect the Clqck calling signal, as indicated by block **70**. In the presently described fast connect protocol, cellular to cellular modem communications are not supported. Therefore, a cellular answer modem will assume that a calling modem transmitted a Clqck signal will transmit only a 1900 hz tone rather than the modulated 1500 and 1900 hz tones. Having said this, it should be appreciated that cellular-to-cellular communications could be supported.

In keeping with the description of FIG. **5**, once the answer modem has received the Clqck calling signal, it transmits the ANSqck answer signal at block **71**. It then waits for the calling modem to enter the modem start-up and training sequence. This sequence is identified by receiving the S signal as assigned by the V.34 modulation standard, as indicated by the decision block **72**. Once this signal is received, then the answer modem will transmit back to the calling modem the appropriate S signal, so as to initiate the startup and training sequence **42**.

Alternatively, if the answer modem, within a period of two seconds, has not received Clqck calling signal, then it will proceed with the start-up sequence in accordance with an alternative modulation standard. This, therefore, assumes that the modified communication protocol of the present invention is not supported by the calling modem, and the answer modem will typically respond to the calling signal of an alternative communication signal by transmitting a 2100 hz tone, as indicated in block **74**.

Referring now to FIG. **6**, a software flowchart illustrating the top-level operation of a central site calling modem is shown. As depicted, the calling modem originates the call and establishes a communication link at block **80**. Once the communication link is established, the calling modem transmits the Clqck calling signal at block **81**, which in the case of a central site calling modem comprises a 1900 hz signal tone. If the 1680 hz ANSqck answer signal is detected at block **82**, then the calling modem recognizes the answer modem as one capable of transmitting pursuant to the fast connect communication protocol. Thereafter, the calling modem must determine the network configuration of the established communication link, as indicated in block **83**. That is, the central site calling modem will determine whether the established communication link passes through a PSTN or not. If it is determined that the established link passes through a PSTN, then, as in the case of the cellular calling modem, the calling modem transmits a 2100 hz signal for approximately one second at block **84**. Thereafter, the calling modem enters the modem start-up and training sequence, as indicated in block **85**.

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Alternatively, if the calling modem detects the ANS answer signal (2100 hz) at block **86**, then it communicates with the answer modem using the ETC1™ communication protocol and the V.32bis training, as indicated by block **87**. If the ANSam answer signal is detected at block **88**, then the modem will startup in standard V.34 mode at block **89**, which is well known in the art and therefore not described herein. The modem will also monitor for ANSqck at block **82**, which in this example is a 1680 Hz tone. If this is not detected, then the modem will startup under an alternate low speed standard at block **90**, which is well known in the art and therefore not described herein. If ANSqck is detected, then the modem will operate differently depending on whether it is connected to the PSTN network or not, as indicated by block **83**. The modem will know whether it is connected to the PSTN via a configuration option which was set at installation. If connected to the PSTN, then the modem will transmit a 2100 Hz tone for one second at block **84** then proceed to the ETC2™ training sequence at block **85**. If the modem is not connected to the PSTN at block **83**, then it can proceed directly to the ETC2™ training sequence at block **85**, avoiding the additional one second of startup shown at block **84**.

Reference is now made to FIG. **7**, which is a software flowchart illustrating the top-level operation of a central site answer modem. As illustrated in the flowchart, and in accordance with the presently disclosed fast connect protocol, when the answer modem is a central-site modem, it assumes that any transmissions made in accordance with the modulation standard with the present invention will be via a communication link with a cellular calling modem. Therefore, block **91** indicates detection the Clqck calling signal in the form of a modulated 1500 and 1900 hz tones, as transmitted by cellular calling modem. If the Clqck calling signal is detected, then the answer modem determines the network configuration at block **92**. More specifically, the answer modem determines whether the established communication link passes through a PSTN or not. In the event that the established link does in fact pass through a PSTN, then the answer modem will transmit an 800 hz ANSqck answer signal at block **93**. As illustrated in FIG. **4**, this instructs the calling modem to transmit the 2100 hz tone. Alternatively, the answer modem will transmit the 1680 hz tone, which instructs the calling modem to proceed directly with the modem start-up and training sequence at block **94**. Thereafter, the answer modem will await transmission of the S signal in accordance with the V.34 start-up sequence, as indicated by block **95**. Thereafter, the answer modem will respond by transmitting the S of the V.34 start-up, as indicated by block **96**. Since the V.34 start-up sequence is well-known in the art, it would not be described herein.

The remainder of the flowchart depicted in FIG. **7** illustrates the central-answer modem operation and connects sequence in accordance with alternative standards that are well-known in the prior art and need not be discussed herein.

Accordingly, at the completion of the automatic mode synchronization sequence **40** (FIG. **2**), the modems enter into a training and start-up sequence **42**. As mentioned above, in the training and startup sequence **42** the modems test the established communication link for noise, bandwidth, etc., in order to determine the appropriate rate for communication. This is performed using the modulation scheme determined in the automatic mode synchronization sequence **40** as illustrated in FIGS. **4**, **5**, **6**, and **7**. For purposes of the following discussion, it is assumed that the call and the answer modems are capable of communicating

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with one another using a fast connect protocol. Consequently, since the call modem knows what type of modem it is and what type of modem the answer modem is, certain shortcuts can be taken during the training and startup sequence 42 so as to reduce the overall connection time. Specifically, the modems can default to preset values that eliminate the need for probing, ranging and half-duplex training. Thus, the modems merely perform a special full-duplex training mode during the training and start-up sequence 42 which results in a much faster connection.

Particularly, the probing and ranging sequences are bypassed and the file parameters are assumed in ITU Standard V.8, INFO0, and INFO1. As an example, in ITU Standard V.8, the data call, the LAPM and the full-duplex training parameters are preset to default values if the tones exchanged during automode sequence indicate that both modems are capable of fast connect operation. Further, in the INFO sequences, the 4 point train, 2800 L symbol rate, the power level drop, and preemphasis filter can also be preset to default values. Thus, the ITU Standard V.8 and INFO sequences are eliminated.

At the completion of the training and start-up sequence 42, the modems have established a physical layer connection and are ready to establish the second layer connection, referred to as the link layer connection, via an error-correction negotiation sequence 44 in accordance with the present invention, as disclosed below.

II. Link Layer Connection

The link layer is the second layer of the ISO model protocol stack and includes negotiating and establishing an error-correcting connection such as with ITU Standard V.42 or Microcom Networking Protocol (MNP). The link layer connection follows the physical layer connection and uses the physical layer in establishing the error-corrected connection. It is noted, however, that conventional wisdom to date has maintained the link layer connection be independent of the physical layer connection when establishing a connection between two modems. In contrast, the present invention establishes the link layer connection based upon the modulation chosen in the physical layer connection during the automatic mode synchronization sequence 40 (FIG. 2). Thus, the steps for establishing an error-correcting protocol are eliminated and the link layer connection is established substantially instantaneously upon the completion of the physical layer negotiation. This not only reduces the amount of time required to establish a connection between two modems, it makes the connection more robust by removing the necessity of performing additional handshaking that, if corrupted for whatever reason, will result in a disconnect or call connect failure.

By way of example, the ITU Standard V.42 (hereafter referred to as V.42) comprises a detection phase, and exchange identification (XID) phase, and a link establishment phase, all of which are briefly discussed below. A more detailed explanation of V.42 can be found in the publicly-available ITU (CCITT) Recommended Standard V.42 documentation.

The detection phase is provided to determine whether the answer modem supports an error-correcting protocol. This phase is designed to avoid the potential disruptions to the answer DTE that could occur if the calling modem immediately enters the XID phase and the answering modem was not capable of an error-correcting communication. However, the detection phase is optional and may be disabled. If the call modem determines that the answering modem does not support a V.42 error-correcting protocol, there are often

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times fall-back error protocols provided by the calling modem, such as in the case of V.42, where MNP is provided as a fall-back error-correcting protocol. Alternatively, if the answer modem does not support V.42 nor MNP, then no error-correcting protocol is established and a connect message is issued by the modems to their respective digital terminal equipment so that user data can be transmitted between the two modems.

The XID phase is provided for the negotiation of the error-correcting parameter values. These parameters essentially govern the error-correcting operation of the modems once the connection is established. As with the detection phase, the XID phase may be omitted if default parameter values are acceptable. For example, the following are provided as the default parameters values in the V.42 standard: Standard Reject, 16 bit FCS (Frame Check Sequence), V.42bis compression disabled, Frame Length (N401) of 128 octets, and Window Size (k) of 15 frames. However, the default settings are more often than not undesirable because, for example, most modems wish to negotiate Selective Reject, V.42bis data compression, and longer Frame Lengths and Window Sizes.

Lastly, the link establishment phase is provided for actually making the error-corrected connection between the two modems. In V.42, this is implemented via a set asynchronous balanced mode extended (SABME) command. The SABME command is used to place the addressed error-corrected entity (i.e., the answering modem) into the connected state. The error-correcting entity then confirms acceptance of the SABME command by the transmission of an unnumbered acknowledgment (UA) response. By acceptance of this command, the error-corrected connection is essentially established and the modems then send a connect message to their respective data terminal equipment, such as computer 15 (FIG. 1).

Unlike the detection phase and the XID phase, the link establishment phase is not optional and must be performed under V.42. Thus, in a best case scenario, only the link establishment phase is performed, which takes approximately 0.5 seconds. If all three phases are performed, then the link layer connection may take three or more seconds.

Therefore, establishing an error-corrected connection with V.42 can take up to three seconds, depending on what defaults are set in the system. While this amount of time does not seem significant relative to the time required for establishing a physical layer connection via V.34 modulation (e.g., approximately 10–15 seconds), it is considerably more noticeable when a fast connect protocol is utilized that can establish a physical layer connection in about 1 second. Thus, when using a fast connect protocol, the error-correction negotiation can easily double the connect time, not to mention introduce a greater opportunity for failure by requiring additional handshaking.

Accordingly, the present invention enables an error-corrected connection without having to perform the steps described above with regard to V.42, or those steps associated with other error-correcting protocols as known in the art. The present invention achieves this by presetting the XID phase parameters to default values that are based upon the negotiated physical layer connection. Therefore, when two multi-mode modems negotiate a physical layer connection, the link layer connection can be immediately established based upon the negotiated physical layer modulation. For example, in the embodiment described above in Section I, the exchange of tones in the mode synchronization sequence 40 indicates to each modem the type of modem it

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is communicating with, and therefore, certain assumptions can then be made regarding the error-correction negotiation sequence **44** so as to eliminate the steps normally performed to establish an error-corrected connection. In the preferred embodiment of the present invention with the V.42 standard, the following parameters are set to the indicated default values when the two modems are capable of the fast connect sequence described above: Selective Reject, 16 bit FCS, 64 bit Maximum Frame Size (transmit and receive directions), 8 Frame Window Size (transmit and receive directions), V.42bis enabled, and 1,024 bit dictionary (transmit and receive directions). It should be noted, however, that one of ordinary skill in the art would recognize that these default values are merely illustrative settings and that different default values can be used. Moreover, each different type of connect sequence would preferably have its own set of default values. If it is determined by the modems in the mode synchronization sequence **40** that one or the other is not capable of a fast connect as described above, then the modems essentially fallback and perform an alternative error-correction sequence such as the recommended ITU Standard V.42 error-correction sequence.

With reference to FIG. **8**, a graphical illustration is provided of two fast connect modems in a first connect sequence **102** where error-correction negotiation is performed without the present invention and a second connect sequence **104** where the error-correction negotiation is performed with the present invention. As shown, following the mode synchronization sequence (also referred to as automode) **40** and the training and start-up sequence **42**, the connect sequence **102** performs error-correction negotiation **44** which essentially doubles the time required for a connection to be established so as to allow user data **106** to be exchanged. In comparison, the connect sequence **104** in accordance with the present invention is able to establish a connection in essentially half the time by eliminating the error-correction negotiation **44**. Thus, by establishing the error-correction parameters to default values in accordance with the type of physical error-connection determined by the automode sequence **40**, a faster and more reliable connection is established.

Regarding the implementation of the present invention, FIG. **9** generally illustrates the components of MSC (cellular) modem **20** and MSC(PSTN) modem **24** which implement the data gateway. The MSC(cellular) modem **20** comprises a digital signal processor (DSP) **112**, a control processor **114**, and a DTE interface **116**. Likewise, the MSC(PSTN) modem **24** comprises a DSP **118**, a control processor **120**, and a DTE interface **122**. The DTE interface **116** of the MSC(cellular) modem **20** interfaces with the DTE interface **122** of the MSC(PSTN) modem **24** via the connection **38**, which can be implemented by any suitable interconnecting device such as, but not limited to, an Electronic Industry Association (EIA) standard RS-232 crossover or a backplane bus between the modems. As shown in FIG. **9**, each modem **20**, **24** is configured essentially the same, and thus, they operate in essentially the same manner. However, each modem is provided with operating code which is stored in a memory device **124**, **124'** provided with the central processor **114**, **120**, respectively, though additional memory can also be provided and connected to the control processor **114**, **120**, if necessary. In the context of the present disclosure, a memory device is a computer readable medium that is embodied in an electronic, magnetic, optical or other physical device or means that can contain or store a computer program, such as the operating code for the modem **20**, **24**, for use by or in connection with a computer

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related system or method. The operating code includes control logic that controls, among other things, the type of modulation and error correction techniques utilized which is dependent upon whether the modem is used for cellular or land-line connections. Accordingly, the control processor **114**, **120** operates on, or executes, the operating code that is in memory device **124**, **124'** and configured for implementing the present invention so as to control the operation of modem **20**, **24**.

The foregoing description has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obvious modifications or variations are possible in light of the above teachings. The embodiment or embodiments discussed were chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly and legally entitled.

Wherefore, the following is claimed:

1. A method for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and a plurality of possible link layer connections and an answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections, comprising the steps of:

establishing a physical layer connection between said calling and said answering modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations; and

establishing said link layer connection based upon said negotiated physical layer modulation.

2. The method of claim 1, wherein said negotiated physical layer modulation is a fast connect modem modulation.

3. The method of claim 1, wherein said link layer connection is an error-correcting protocol.

4. The method of claim 1, further comprising the step of presetting link layer parameters of said link layer connection to default settings based on said negotiated physical layer modulation.

5. The method of claim 3, wherein said error-correcting protocol includes parameters that are set to pre-defined settings based on said negotiated physical layer modulation.

6. A system for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and a plurality of possible link layer connections and an answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections, comprising:

means for establishing a physical layer connection between said calling and said answering modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations; and

means for establishing said link layer connection based upon said negotiated physical layer modulation.

7. The system of claim 6, wherein said negotiated physical layer modulation is a fast connect modem modulation.

8. The system of claim 6, wherein said link layer connection is an error-correcting protocol.

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9. The system of claim 6, further comprising means for presetting link layer parameters of said link layer connection to pre-defined settings based on said negotiated physical layer modulation.

10. A computer program product having a computer readable medium including computer program logic recorded thereon for use in a calling modem for establishing a link layer convention between said calling modem having a plurality of possible first physical layer modulations and a plurality of possible link layer connections and an answering modem having a plurality of possible second physical layer

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modulations and a plurality of possible second link layer connections, comprising:

logic for establishing a physical layer connection between said calling and said answering modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations; and

logic for establishing link layer connection based upon said negotiated physical layer modulation.

* * * * *

Exhibit 4

[11] Patent Number: 5,243,627

[45] **Date of Patent:** Sep. 7, 1993

[54] SIGNAL POINT INTERLEAVING
TECHNIQUE

[75] Inventors: William L. Betts, St. Petersburg;
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[21] Appl. No.: 748,594

[22] Filed: Aug. 22, 1991

[51] Int. Cl.⁵ H04L 5/12

[52] U.S. Cl. 375/39; 375/60;
375/99; 371/43

[58] Field of Search 375/39, 58, 60, 99;
371/43, 37 5, 2.1, 45; 341/81

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Attorney, Agent, or Firm—Ronald D. Slusky; Gerard A. deBlasi

[57] ABSTRACT

Viterbi decoder performance in a data communication system using $2N$ -dimensional channel symbols $N > 1$ can be further enhanced by an interleaving technique which uses a distributed trellis encoder in combination with a signal point interleaver.

24 Claims, 4 Drawing Sheets

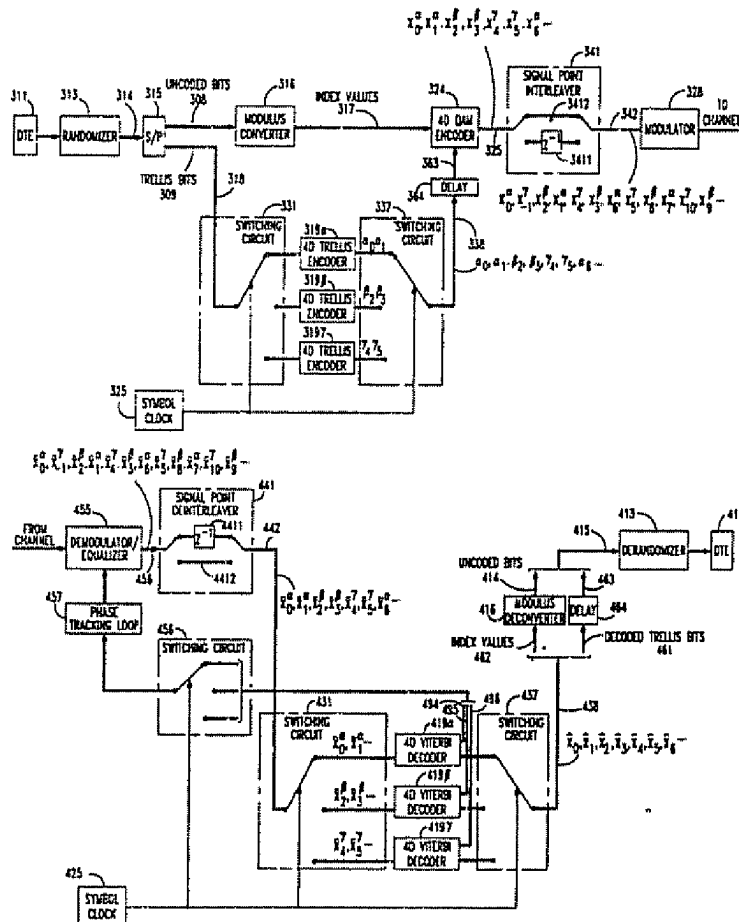


FIG. 1

PRIOR ART

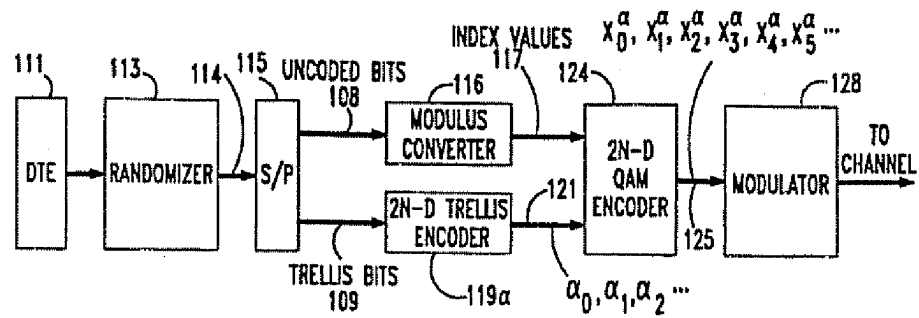


FIG. 2

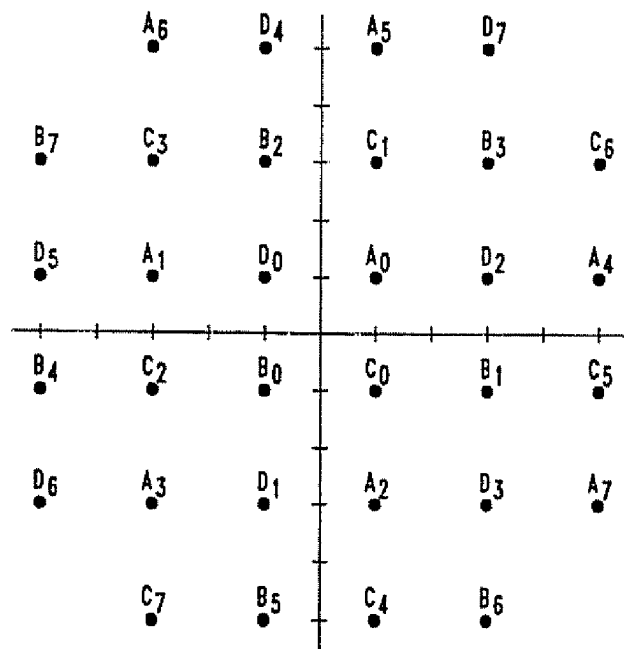


FIG. 3

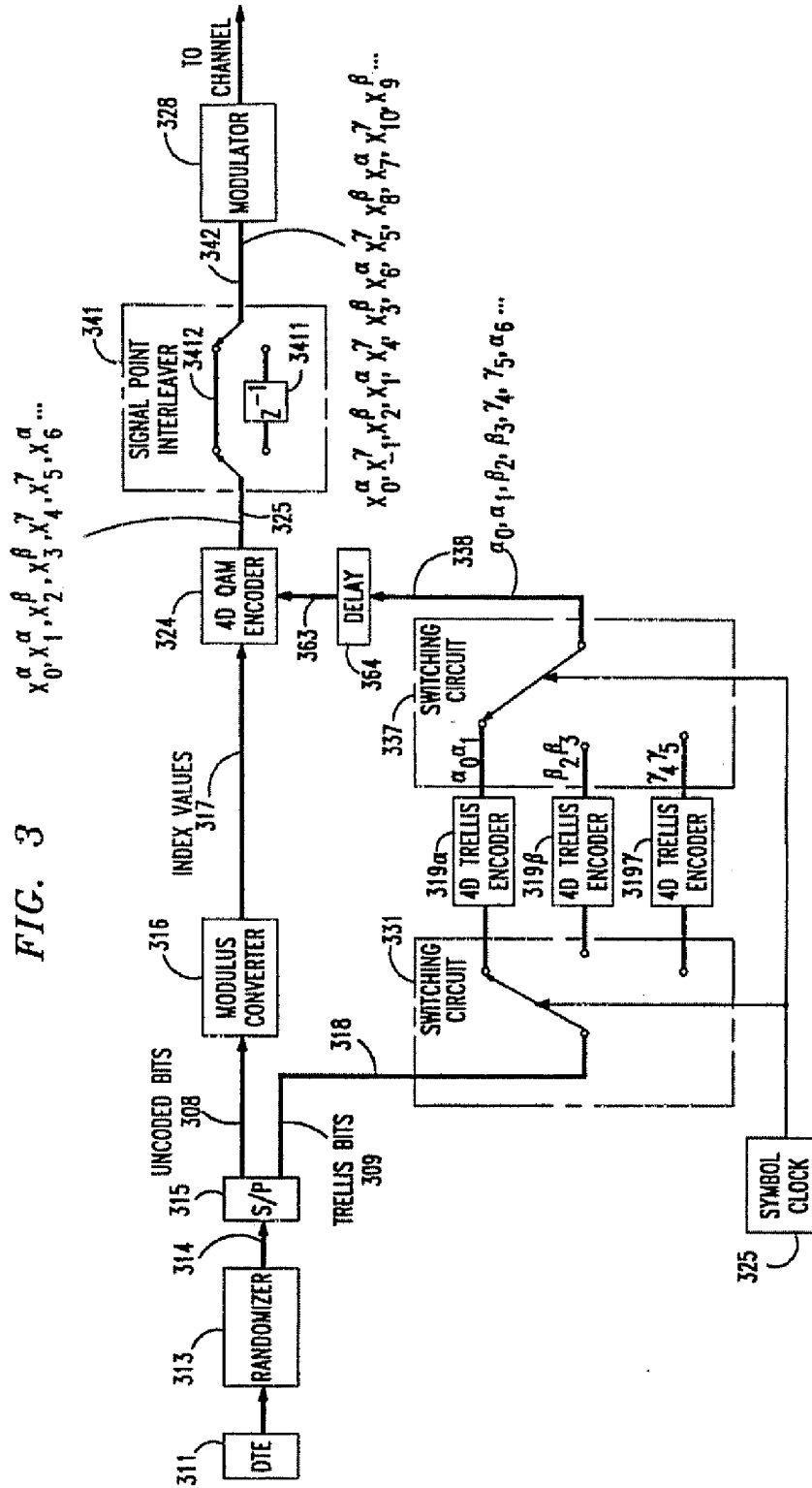


FIG. 4

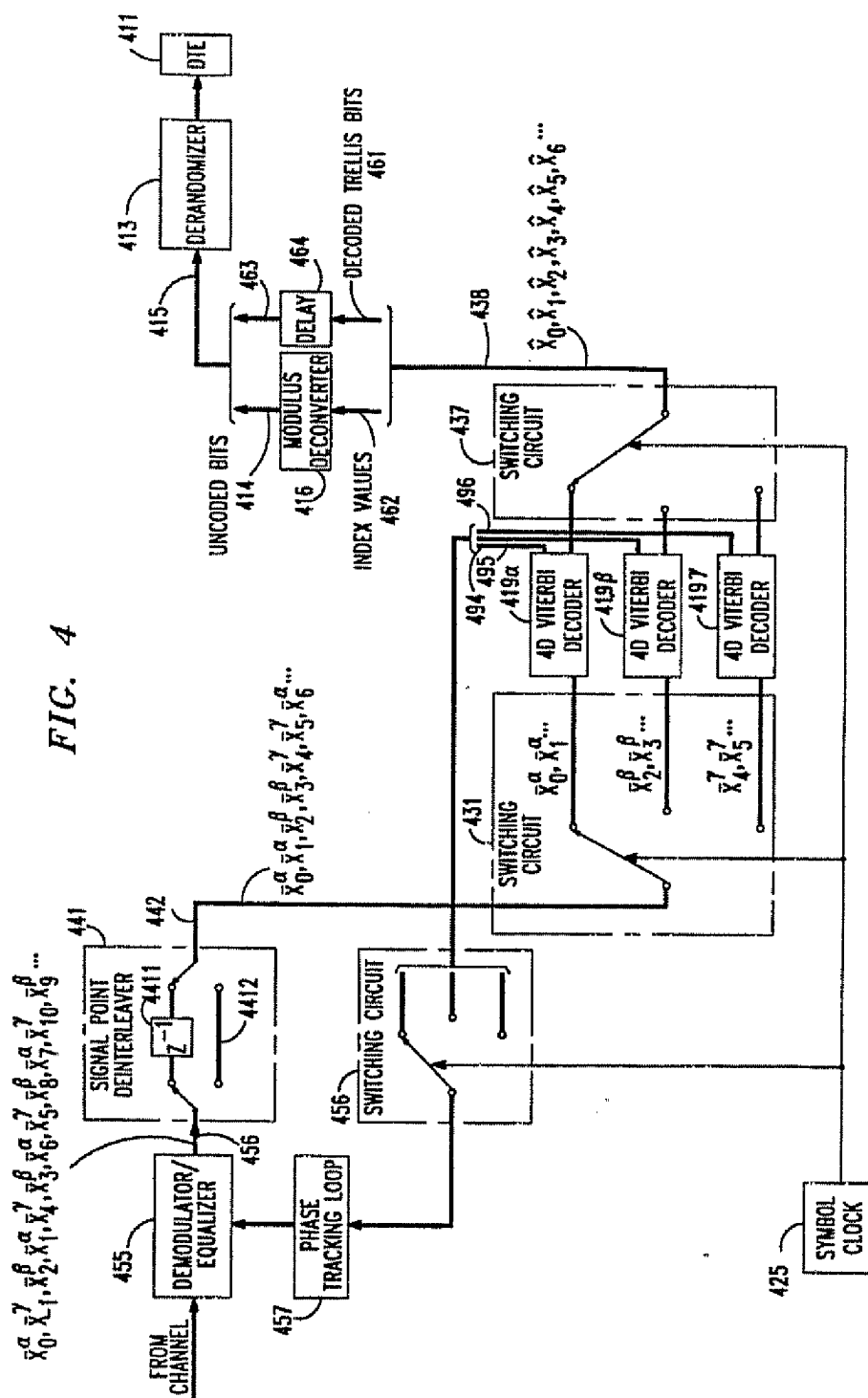


FIG. 5

		4D SYMBOL	4D SYMBOL	4D SYMBOL	4D SYMBOL	4D SYMBOL	4D SYMBOL
I	NOT INTERLEAVED ONE TRELLIS STAGE	x_0^α	x_1^α	x_2^α	x_3^α	x_4^α	x_5^α
II	NOT INTERLEAVED THREE TRELLIS STAGES	x_0^α	x_1^α	x_2^β	x_3^β	x_4^γ	x_5^γ
III	INTERLEAVED ONE TRELLIS STAGE	x_0^α	x_{-1}^α	x_2^α	x_1^α	x_4^α	x_3^α
IV	INTERLEAVED TWO TRELLIS STAGES	x_0^α	x_{-1}^β	x_2^β	x_1^α	x_4^α	x_3^β
V	INTERLEAVED THREE TRELLIS STAGES	x_0^α	x_{-1}^γ	x_2^β	x_1^α	x_4^γ	x_3^β

FIG. 6

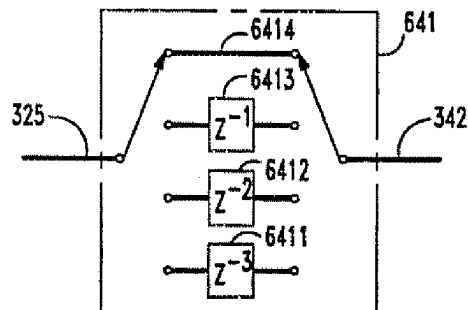
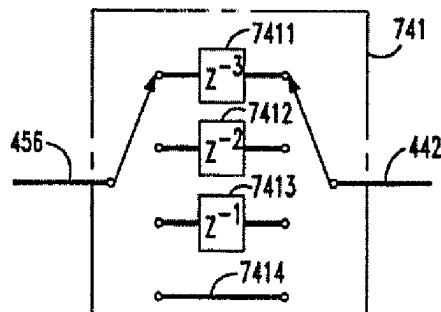


FIG. 7



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SIGNAL POINT INTERLEAVING TECHNIQUE

BACKGROUND OF THE INVENTION

The present invention relates to the transmission of digital data over band-limited channels.

Over the years, the requirements of modern-day digital data transmission over band-limited channels—such as voiceband telephone channels—have resulted in a push for higher and higher bit rates. This push has led to the development and introduction of such innovations as adaptive equalization, multi-dimensional signal constellations, echo cancellation (for two-wire applications), and trellis coding. Today, the data rates achieved using these and other techniques are beginning to approach the theoretical limits of the channel.

It has been found that various channel impairments, whose effects on the achievable bit rate were relatively minor compared to, say, additive white Gaussian noise and linear distortion, have now become of greater concern. These include such impairments as nonlinear distortion and residual (i.e., uncompensated-for) phase jitter. Such impairments are particularly irksome in systems which use trellis coding. Indeed, it has been found that the theoretical improvement in Gaussian noise immunity promised by at least some trellis codes is not realized in real-world applications where these impairments are manifest. The principal reason this is so appears to be that the noise components introduced into the received signal samples are such as to worsen the effectiveness of the Viterbi decoder used in the receiver to recover the transmitted data.

U.S. Pat. No. 4,677,625, issued Jun. 30, 1987 to Betts et al, teaches a method and arrangement in which, through the use of a distributed trellis encoder/Viterbi decoder, the effects of many of these impairments can be reduced. The invention in the Betts et al patent recognizes that a part of the reason that the performance of the Viterbi decoder is degraded by these impairments is the fact that the noise components of channel symbols which closely follow one another in the transmission channel are highly correlated for many types of impairments. And it is that correlation which worsens the effect that these impairments have on the Viterbi decoder. Among the impairments whose noise is correlated in this way are impulse noise, phase "hits" and gain "hits." All of these typically extend over a number of adjacent channel symbols in the channel, and thus all result in channel symbol noise components which are highly correlated. The well-known noise enhancement characteristics of linear equalizers also induce correlated noise in adjacent channel symbols, as does uncompensated-for phase jitter. Also, the occurrence of one of the relatively high power points of the signal constellation can, in pulse code modulation (PCM) systems, for example, give rise to noise on adjacent channel symbols which, again, is correlated.

The Betts et al patent addresses this issue by distributing the outgoing data to a plurality of trellis encoders in round-robin fashion and interleaving the trellis encoder outputs on the transmission channel. In the receiver, the stream of received interleaved channel symbols is correspondingly distributed to a plurality of trellis decoders. Since the successive pairs of channel symbols applied to a particular trellis decoder are separated from one another as they traverse the channel, the correlation of the noise components of these channel symbol

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pairs is reduced from what it would have otherwise been.

SUMMARY OF THE INVENTION

In accordance with the present invention, it has been realized that the Viterbi decoder performance in a data communication system using 2N-dimensional channel symbols can be further enhanced by an interleaving technique which uses, in combination, a) the aforementioned distributed trellis encoder/Viterbi decoder technique and b) a signal point interleaving technique which causes the constituent signal points of the channel symbols to be non-adjacent as they traverse the channel.

In preferred embodiments of the invention, the interleaving is carried out in such a way that every N^{th} signal point in the signal point stream traversing the channel is the N^{th} signal point of a respective one of the channel symbols. This criterion enhances the accuracy with which the phase tracking loop in the receiver performs its function.

Also in preferred embodiments, we have found that the use of three parallel trellis encoders in conjunction with a signal point interleaving regime in which the signal points of each channel symbol are separated from one another by three signaling intervals (bauds) provides an optimum or near-optimum tradeoff between signal point/channel symbol separation and the decoding delay that is caused by the interleaving.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing,

FIG. 1 is a block diagram of the transmitter section of a prior art modem;

FIG. 2 is shows a signal constellation used by the transmitter of FIG. 1;

FIG. 3 is a block diagram of the transmitter section of a modem employing four-dimensional channel symbols and embodying the principles of the invention;

FIG. 4 is a block diagram of the receiver section of a modem embodying the principles of the invention which processes the received four-dimensional channel symbols generated by the transmitter of FIG. 3;

FIG. 5 is a signal point timing/sequencing chart helpful in explaining the principles of the present invention;

FIG. 6 is a signal point interleaver which can be used in the transmitter of FIG. 3 to interleave the signal points of eight-dimensional channel symbols; and

FIG. 7 is a signal point deinterleaver which can be used in the receiver of FIG. 4 to deinterleave the signal points of eight-dimensional channel symbols.

DETAILED DESCRIPTION

FIG. 1 depicts the transmitter section of a prior art modem employing a 2N-dimensional signaling scheme, $N \geq 1$. The modem receives input information in the form of a serial bit stream from data terminal equipment (DTE) 111—illustratively a host computer. That bit stream is then scrambled, or randomized, by randomizer 113 whose output bits are provided in serial form to serial-to-parallel (S/P) converter 115.

Serial-to-parallel converter 115, in turn, provides, during each of a succession of symbol intervals (comprised of N baud intervals), some predetermined number of parallel bits on lead 109 and some number of parallel bits on lead 108. (It will be appreciated that whenever bits are provided in parallel in the modem, separate leads are required to carry each of the bits.) The bits on lead 109 are applied to trellis encoder 119a,

and are referred to as the "trellis bits." The bits on lead 108 are applied to modulus converter 116, and are referred to as the "uncoded bits."

To better understand how trellis encoder 119a and modulus converter 116 work, reference is made to FIG. 2, which shows the two-dimensional signal constellation that forms the basis of the 2N-dimensional signaling scheme illustratively used by the modem. This constellation is comprised of 32 signal points, which are divided into four subsets, A through D, each comprised of eight signal points. The eight points of subset A are explicitly labeled as A₀ through A₇. It may be noted that subsets C, B and D can be arrived at by clockwise rotation of subset A by 90, 180 and 270 degrees, respectively. (Conventional differential encoding circuitry within trellis encoder 119a exploits this symmetry.) For reference, a single signal point of each of those subsets is also shown on FIG. 2.

Consider, first, the case of N=1, i.e., a two-dimensional signaling scheme. In this case, one trellis bit on lead 109 would be expanded to two bits by trellis encoder 119a on lead 121. The four possible values of those three bits 00, 01, 10, and 11 identify subsets A, B, C and D, respectively. The successive 2-bit words on lead 121 are represented as α_n , $n=0,1,2,\dots$, where n is an index that advances at the baud rate. At the same time, three parallel bits would be provided on lead 108. These are converted by modulus converter 116 into an index having a value within the range (decimal) 0 to 7. The index value, represented in binary form on lead 117, selects a particular signal point from the subset identified on lead 121. Thus if lead 121 carries the two bits 00 while lead 117 carries the three bits 001, then signal point A₁ of the FIG. 2 constellation has been selected. The words on leads 117 and 121 are applied to QAM encoder 124 which generates, on lead 125, values representing the I (in-phase) and Q (quadrature-phase) components of signal point A₁. The signal point generated on lead 125 in the nth baud interval is denoted X_n ^{α} , which is passed on to modulator 128 to generate a pass-band line signal which is applied to the communication channel. The superscript, α , indicates that the trellis encoder that was used to identify the subset for any particular signal point was trellis encoder 119a. That is, of course, a trivial notation as far as FIG. 1 goes inasmuch as trellis encoder 119a is the only trellis encoder in the modem. However, it is useful to introduce this notation because more than one trellis encoder stage is used in preferred embodiments of modems incorporating the principles of the present invention as shown in later FIGS.

In the case of N>1, the operation is similar. Now, however, the words on lead 109 are used by trellis encoder 119a to sequentially identify on lead 121N subsets, while the words on lead 108 are used to generate N corresponding index values on lead 117. The N signal points identified in this way are the component signal points of a 2N-dimensional channel symbol, the first such symbol being comprised of the signal points X₀ ^{α} , \dots , X_(N-1) ^{α} . For example, a modem in which the transmitter of FIG. 1 could be used may be a 14,400 bit per second modem using four-dimensional coding (i.e., N=2) and a baud rate of 3200. In this case, nine bits from S/P converter 115 are used for each four-dimensional symbol. Specifically, three parallel bits on lead 109 are expanded into four bits on lead 121 to identify a pair of subsets while six bits on lead 108 are used to select particular signal points from those two subsets.

Those two signal points are thereupon communicated over the channel by QAM encoder 124 and modulator 128 as described above.

Note that, implementationally, the 2N-dimensional channel symbol is generated by having the trellis encoder identify, interdependently, N subsets of the two-dimensional constellation of FIG. 2, then select a two-dimensional signal point from each of the subsets thus identified. The concatenation of the N two-dimensional signal points thus selected is the desired 2N-dimensional channel symbol. This process, however, can be understood as involving the direct selection of a 2N-dimensional channel symbol. Viewed in this context, the set of all possible combinations of N of the two-dimensional subsets identified by N successive trellis encoder outputs can be understood to be a set of 2N-dimensional subsets of a 2N-dimensional constellation, the latter being comprised of all possible combinations of N of the signal points of the two-dimensional constellation. A succession of N outputs from the trellis encoder identifies a particular one of the 2N-dimensional subsets and a succession of N outputs from the modulus converter selects a particular 2N-dimensional signal point from the identified 2N-dimensional subset.

Modulus converter 116 is illustratively of the type disclosed in co-pending, commonly-assigned U.S. patent application Ser. No. 588,658 filed Sep. 26, 1990 and allowed on May 21, 1991, hereby incorporated by reference. Modulus converter 116 provides the modem with the ability to support data transmission at various different bit rates. Assume, for example, that the rate at which bits are provided by DTE 111 decreases. The serial-to-parallel converter will continue to provide its outputs on leads 108 and 109 at the same baud rate as before. However, the upper limit of the range of index values that are provided by modulus converter 116 on lead 117 will be reduced, so that, effectively, each of the four subsets A through D, instead of having eight signal points, will have some smaller number. Conversely if the rate at which bits are provided by DTE 111 should increase over that originally assumed, the upper limit of the range of index values, and thus the number of parallel bits, that appear on lead 117 will be increased beyond eight and the constellation itself will be expanded to accommodate the larger number of signal points thus being selected. As an alternative to using a modulus converter, fractional bit rates can be supported using, for example, the technique disclosed in L. Wei, "Trellis-Coded Modulation with Multidimensional Constellations," *IEEE Trans. on Communication Theory*, Vol. IT-33, No. 4, July 1987, pp. 483-501.

Turning now to FIG. 3, the transmitter portion of a modem embodying the principles of the invention is shown. This embodiment illustratively uses the aforementioned four-dimensional, i.e., N=2, signaling scheme. Many of the components are similar to those shown in FIG. 1. Thus, in particular, the transmitter of FIG. 3—which receives its input information in the form of a stream of input bits from DTE 311—includes randomizer 313, which supplies its output, on lead 314, to S/P converter 315. The latter outputs uncoded bits to modulus converter 316. The transmitter further includes four-dimensional QAM encoder 324 and modulator 328. The trellis bits, on lead 309, are provided not to a standard single trellis encoder, but to a distributed trellis encoder comprised of three trellis encoder stages: trellis encoder stage 319a, trellis encoder stage 319b, and trellis encoder stage 319c.

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Such a distributed trellis encoder, which is described in the aforementioned Betts et al patent, generates a plurality of streams of trellis encoded channel symbols in response to respective portions of the input information. Specifically, a three-bit word on lead 309 is supplied to trellis encoder stage 319 α . The next three-bit word on lead 309 is supplied to trellis encoder stage 319 β . The next three-bit word is supplied to trellis encoder stage 319 γ , and then back to trellis encoder stage 319 α . This distribution of the trellis bits to the various trellis encoder stages is performed by switching circuit 331 operating under the control of symbol clock 325. The initial data word outputs of the trellis encoders are subset identifiers α_0 and α_1 for encoder stage 319 α , β_2 and β_3 for encoder stage 319 β , and γ_4 and γ_5 for encoder stage 319 γ , followed by α_6 and α_7 for encoder stage 319 α , and so forth. These are supplied to four-dimensional QAM encoder 324 by switching circuit 337—also operating under the control of symbol clock 325—on lead 338 through a one-symbol delay 364 and lead 363, in order to compensate for a one-symbol delay caused by modulus converter 316. Thus, the stream of subset identifiers on lead 338 is $\alpha_0, \alpha_1, \beta_2, \beta_3, \gamma_4, \gamma_5, \alpha_6, \dots$. Using the notation introduced above, then, the output of encoder 324 on lead 325 is the stream of signal points $X_{0\alpha}, X_{1\alpha}, X_{2\beta}, X_{3\beta}, X_{4\gamma}, X_{5\gamma}, X_{6\alpha}, \dots$, which is comprised of three interleaved streams of trellis encoded channel symbols, these streams being $X_{0\alpha}, X_{1\alpha}, X_{6\alpha}, X_{7\alpha}, X_{12\alpha}, \dots$; $X_{2\beta}, X_{3\beta}, X_{8\beta}, X_{9\beta}, X_{14\beta}, \dots$; and $X_{4\gamma}, X_{5\gamma}, X_{10\gamma}, X_{11\gamma}, X_{16\gamma}, \dots$. These, in turn, are supplied, in accordance with the invention, to signal point interleaver 341 which applies alternate ones of the signal points applied thereto to lead 341 2 —which signal points appear immediately at the interleaver output on lead 342—and to one-symbol (Z^{-1}) delay element 341 1 , which appear on lead 342 after being delayed therein by one symbol interval. The resulting interleaved stream of trellis encoded signal points is $X_{0\alpha}, X_{-1\gamma}, X_{2\beta}, X_{1\alpha}, X_{4\gamma}, X_{3\beta}, X_{6\alpha}, X_{5\gamma}, X_{8\beta}, X_{7\alpha}, X_{10\gamma}, X_{9\beta}, \dots$ (the signal point $X_{-1\gamma}$ being, of course, the signal point applied to interleaver 341 just ahead of signal point $X_{0\alpha}$).

A discussion and explanation of how the interleaving just described is advantageous is set forth hereinbelow. In order to fully set the stage for that explanation, however, it will be first useful to consider the receiver section of a modem which receives the interleaved signal point stream.

Thus referring to FIG. 4, the line signal transmitted by the transmitter of FIG. 3 is received from the channel and applied to demodulator/equalizer 455 which, in conventional fashion—including an input from phase tracking loop 457—generates a stream of outputs on lead 456 representing the demodulator/equalizer's best approximation of the values of the I and Q components of the signal points of the transmitted interleaved signal point stream. These outputs are referred to herein as the "received signal points." (Due to distortion and other channel impairments that the demodulator/equalizer is not able to compensate for, the I and Q components of the received signal points, instead of having exact integer values, can have any value. Thus a transmitted signal point having coordinates (3, -5) may be output by the demodulator/equalizer as the received signal point (2.945, -5.001).) The stream of received signal points on lead 456 is denoted $\bar{X}_{0\alpha}, \bar{X}_{-1\gamma}, \bar{X}_{2\beta}, \bar{X}_{1\alpha}, \bar{X}_{4\gamma}, \bar{X}_{3\beta}, \bar{X}_{6\alpha}, \bar{X}_{5\gamma}, \bar{X}_{8\beta}, \bar{X}_{7\alpha}, \bar{X}_{10\gamma}, \bar{X}_{9\beta}, \dots$.

The successive received signal points are deinterleaved in signal point deinterleaver 441, which provides

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the opposite function to interleaver 341 in the transmitter. The output of deinterleaver 441 on lead 442 is thus $\bar{X}_{0\alpha}, \bar{X}_{1\alpha}, \bar{X}_{2\beta}, \bar{X}_{3\beta}, \bar{X}_{4\gamma}, \bar{X}_{5\gamma}, \bar{X}_{6\alpha}, \dots$, etc. (Although not explicitly shown in the drawing, the same well-known techniques used in modems of this general kind to identify within the stream of received signal points the boundaries between successive symbols is used to synchronize the operation of signal point deinterleaver 441 to ensure that received signal points $\bar{X}_{0\alpha}, \bar{X}_{2\beta}, \bar{X}_{4\gamma}, \dots$ are applied to delay element 441 1 while received signal points $\bar{X}_{1\alpha}, \bar{X}_{3\beta}, \bar{X}_{5\gamma}, \dots$ are applied to lead 441 2 .)

The received signal points on lead 442 are then distributed by switching circuit 431 under the control of symbol clock 425 to a distributed Viterbi decoder comprised of 4D Viterbi decoder stages 419 α , 419 β and 419 γ . Specifically, received signal points $\bar{X}_{0\alpha}$ and $\bar{X}_{1\alpha}$ are applied to decoder stage 419 α ; received signal points $\bar{X}_{2\beta}$ and $\bar{X}_{3\beta}$ are applied to decoder stage 419 β ; and received signal points $\bar{X}_{4\gamma}$ and $\bar{X}_{5\gamma}$ are applied to decoder stage 419 γ . The outputs of the three decoder stages are then combined into a serial stream on lead 438 by switching circuit 437, also operating under the control of symbol clock 425. Those outputs, representing decisions as to the values of the transmitted signal points, are denoted $\hat{X}_0, \hat{X}_1, \hat{X}_2, \hat{X}_3, \hat{X}_4, \hat{X}_5, \hat{X}_6, \dots$, the α, β and γ superscripts no longer being needed.

In conventional fashion, the bits that represent each of the decisions on lead 438 can be divided into bits that represent a) the trellis bits that appeared on transmitter lead 309 and b) the index values that appeared on transmitter lead 317. Those two groups of bits are provided in the receiver on leads 461 and 462, respectively. The latter group of bits are deconverted by modulus deconverter 416 (also disclosed in the aforementioned '658 patent application) back to uncoded bit values on lead 414. The operation of the modulus deconverter imparts a one-symbol delay to the bits on lead 414. Accordingly, the bits on lead 461 are caused to be delayed by one symbol by delay element 464. The resulting combined bits on lead 415 thus represent the stream of bits that appeared at the output of randomizer 313 in the transmitter. These are derandomized in the receiver by derandomizer 413 and the resulting derandomized bit stream is applied to DTE 411 which may be, for example, a computer terminal.

Referring to FIG. 5, one can see the improvement that is achieved by the present invention.

Line I shows the stream of output signal points generated and launched into the channel using one stage of trellis encoding and no signal point interleaving. This is, of course, the prior art arrangement shown in FIG. 1. Line II shows the effect of providing a three-stage distributed trellis encoder but still no signal point interleaving. This is the arrangement shown in the aforementioned Betts et al patent. Note that the signal points of each channel symbol operated on by a particular trellis encoder stage are adjacent in the output signal point stream. For example, the second signal point of the symbol $X_{0\alpha} X_{1\alpha}$ —namely signal point $X_{1\alpha}$ —is separated by five baud intervals from the first (closer) signal point of the symbol $X_{6\alpha} X_{7\alpha}$ —namely signal point $X_{6\alpha}$. As noted earlier, such separation is advantageous because the channel symbols which are processed one after the other in a particular Viterbi decoder stage have noise components which are not highly correlated.

Note, however, that the individual signal points of each channel symbol, e.g., $X_{0\alpha}$ and $X_{1\alpha}$, are adjacent to

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one another as they pass through the channel; and since all the signal points of a channel symbol must be processed serially in the same Viterbi decoder stage, this means that the Viterbi decoder must process adjacent signal points that have highly correlated noise components.

It is to this end that signal point interleaver 341 is included within the transmitter in accordance with the invention. Firstly, it may be noted from Line III that using the signal point interleaver without the distributed trellis encoder—an arrangement not depicted in the drawing—will, advantageously, cause the signal points from the same channel symbol to be non-adjacent. Moreover, there is further advantage in that a pair of channel symbols processed serially by Viterbi decoder stage 419 α traverses the channel separated by five baud intervals rather than three, thereby providing greater decorrelation of the noise components thereof. Compare, for example, the span of baud intervals occupied by signal points X_0^α and X_1^α , X_2^α and X_3^α in Line I and the span of baud intervals occupied by the same signal points in Line III. Disadvantageously, however, the use of a single trellis encoding stage brings back the problem that the distributed trellis encoder solves, as described above. Thus, for example, although signal points X_0^α and X_1^α , which are from the same channel symbol, are separated from one another when traversing the channel, we find that, disadvantageously, signal points X_2^α and X_1^α , which are signal points from two different channel symbols which will be processed serially by the Viterbi decoder, traverse the channel adjacent to one another.

Line IV shows that using the signal point interleaver with a two-stage trellis encoder—also an arrangement not depicted in the drawing—provides some improvement. Firstly, it may be noted that, as in Line III, signal points from the same channel symbol remain separated by three baud intervals. Additionally, pairs of channel symbols processed sequentially by a given Viterbi decoder stage—such as the channel symbols comprised of signal points X_0^α and X_1^α , X_4^α and X_5^α —are still non-adjacent and, indeed, are now separated by seven baud intervals, which is even greater than the separation of five baud intervals provided in Line III. Moreover, certain signal points that traverse the channel adjacent to one another and which are from channel symbols which would have been decoded sequentially in the one-trellis-encoding-stage case are, in the two-trellis-encoding-stage case of Line IV, processed by different Viterbi decoding stages. Signal points X_2^β and X_1^α are such a pair of signal points. Note, however, that, disadvantageously, signal points X_1^α and X_4^α traverse the channel serially, and are from channel symbols which are serially processed by the “ α ” Viterbi decoder stage.

Referring, however, to Line V, which depicts the stream of signal points output by the transmitter of FIG. 3, it will be seen that, in accordance with the invention, there is still a non-adjacency—indeed, a separation of at least three baud intervals—between a) the signal points which belong to any particular channel symbol (and which, therefore, are processed serially by a particular Viterbi decoder stage) and b) the signal points which belong to channel symbols which are processed serially by a Viterbi decoder stage. Thus, for example, signal points X_1^α and X_4^γ are now processed by different Viterbi decoder stages. Moreover, pairs of channel symbols processed sequentially by a given Viterbi decoder stage—such as the channel symbols comprised of

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signal points X_0^α and X_1^α , X_6^α and X_7^α —are now separated by none baud intervals.

Using more than three trellis encoder stages in the distributed trellis encoder and/or a signal point interleaver that separates signal points from the same channel symbol by more than three baud intervals would provide even greater separation and could, therefore, potentially provide even greater improvement in Viterbi decoding. However, such improvement comes at a price—that price being increased decoding delay—particularly as the number of trellis encoders is increased beyond three. An engineering trade-off can be made, as suits any particular application.

Moreover, it is desirable for the signal point interleaver to provide a sequence in which every N^{th} signal point in the interleaved signal point stream is the N^{th} signal point of a channel symbol (The reason this is desirable is described in detail hereinbelow.) In the case of an $N=2$, four-dimensional signaling scheme, this means that every second, that is “every other,” signal point in the interleaved stream is the second signal point of the channel symbol from which it comes. In the case of an $N=4$, eight-dimensional signaling scheme, this means that every fourth signal point in the interleaved stream is the fourth signal point of the channel symbol from which it comes. Indeed, this criterion is in fact satisfied in the embodiment of FIG. 3. Note that each one of signal points X_0^α , X_2^β , X_4^γ , X_6^α , . . . , which appear as every other signal point in the interleaved stream, is the second signal point of one of the four-dimensional channel symbols. Note that not all rearrangements of the signal points will, in fact, satisfy this criterion, such as, if the two signal points of a channel symbol are separated by two, rather than three, baud intervals.

Satisfying the above criterion is advantageous because it enhances the accuracy with which phase tracking loop 457 performs its function. This is so because the arrival of an N^{th} signal point of a given symbol means that all the signal points comprising that channel symbol have arrived. This, in turn, makes it possible to form a decision as to the identity of that channel symbol by using the minimum accumulated path metric in the Viterbi decoder stages. (Those decisions are fed back to the tracking loop by decoder stages 419 α , 419 β 419 γ on leads 494, 495 and 496, respectively, via switching circuit 456.) Without having received all of the signal points of a channel symbol, one cannot take advantage of the accumulated path metric information but, rather, must rely on the so-called raw sliced values, which is less accurate. By having every N^{th} signal point in the interleaved stream be the N^{th} signal point of a channel symbol, we are guaranteed that the time between adjacent such path metric “decisions” supplied to the phase tracking loop is, advantageously, never more than N baud intervals.

The foregoing merely illustrates the principles of the invention. Thus although the illustrative embodiment utilizes a four-dimensional signaling scheme, the invention can be used with signaling schemes of any dimensionality. In the general, $2N$ -dimensional, case each stage of the distributed trellis encoder would provide N two-dimensional subset identifiers to switching circuit 337 before the latter moves on to the next stage. And, of course, each stage of the distributed Viterbi decoder would receive N successive received signal points. The distributed trellis encoder and distributed Viterbi decoder can, however, continue to include three trellis

encoders and still maintain, independent of the value of N , a separation of three baud intervals in the channel between signal points that are from channel symbols that are adjacent in the trellis encoder. If a greater separation of such signal points is desired, more stages can be added to the distributed trellis encoder/Viterbi decoder, just as was noted above for the four-dimensional case. However, when dealing with $2N$ -dimensional signaling where $N > 2$, it is necessary to add additional delay elements to the signal point interleaver/deinterleaver in order to maintain a three-baud-interval separation among the signal points from any given channel symbol.

Consider, for example, the case of $N=4$, i.e., an eight-dimensional case. Looking again at FIG. 3, the three (8D) stages of the distributed trellis encoder would generate the three streams of subset identifiers $\alpha_0 \alpha_1 \alpha_2 \alpha_3 \alpha_{12} \dots \beta_4 \beta_5 \beta_6 \beta_7 \beta_{16} \dots$, and $\gamma_8 \gamma_9 \gamma_{10} \gamma_{11} \gamma_{20} \dots$, respectively. This would lead to the following stream of signal points of eight-dimensional trellis encoded channel symbols at the output of the QAM encoder on lead 325: $X_0^\alpha X_{1^\alpha} X_{2^\alpha} X_{3^\alpha} X_{4^\beta} X_{5^\beta} X_{6^\beta} X_{7^\beta} X_{8^\gamma} X_{9^\gamma} X_{10^\gamma} X_{11^\gamma} X_{12^\alpha} \dots$. Signal point interleaving could be carried out by substituting signal point interleaver 641 of FIG. 6 for interleaver 341. Interleaver 641, in addition to direct connection 6414, includes one-, two-, and three-symbol delay elements 6413, 6412 and 6411, respectively.

The signal points on lead 325, after passing through interleaver 641, would appear on lead 342 in the following order: $X_0^\alpha X_{-3^\gamma} X_{-6^\beta} X_{-9^\alpha} X_{4^\beta} X_{1^\alpha} X_{-2^\gamma} X_{-5^\beta} X_{8^\gamma} X_{5^\beta} X_{2^\alpha} X_{-1^\gamma} X_{12^\alpha} X_{9^\gamma} X_{6^\beta} X_{3^\alpha} X_{16^\beta} X_{13^\alpha} X_{10^\gamma} X_{7^\beta} \dots$ where signal points with negative subscripts are, of course, signal points that arrived before signal point X_0^α and were already stored in the delay elements 6411, 6412 and 6413. Examination of this signal point stream will reveal that there is either a three- or five-baud separation between signal points of channel symbols that are processed sequentially by the same trellis encoder stage, e.g., X_{3^α} and X_{12^α} ; that adjacent signal points of any one channel symbol, e.g., X_0^α and X_{1^α} , are separated by five baud intervals; and that the four signal points comprising any particular one channel symbol are separated by fifteen baud intervals.

FIG. 7 shows the structure of a deinterleaver 741 that could be used in the receiver of FIG. 4 in place of deinterleaver 441 in order to restore the signal points of the eight-dimensional channel symbols to their original order. This structure, which is the inverse of interleaver 641, includes delay stages 7411, 7412 and 7413, as well as direct connection 7414.

It will be appreciated that, although various components of the modem transmitter and receiver are disclosed herein for pedagogic clarity as discrete functional elements and indeed—in the case of the various switching circuits—as mechanical elements, those skilled in the art will recognize that the function of any one or more of those elements could be implemented with any appropriate available technology, including one or more appropriately programmed processors, digital signal processing (DSP) chips, etc. For example, multiple trellis encoders and decoders can be realized using a single program routine which, through the mechanism of indirect addressing of multiple arrays within memory, serves to provide the function of each of the multiple devices.

It will thus be appreciated that those skilled in the art will be able to devise numerous arrangements which,

although not explicitly shown or described herein, embody the principles of the invention and are within its spirit and scope.

We claim:

1. Apparatus for forming a stream of trellis encoded signal points in response to input information, said apparatus comprising

means for generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said input information, each of said channel symbols being comprised of a plurality of signal points, and

means for interleaving the signal points of said generated channel symbols to form said stream of trellis encoded signal points, said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points.

2. The apparatus of claim 1 wherein said means for generating generates three of said streams of trellis encoded channel symbols, and wherein said means for interleaving causes there to be interleaved between each of the signal points of each channel symbol at least two signal points from other channel symbols of said streams of trellis encoded channel symbols.

3. The apparatus of claim 1 wherein said channel symbols are $2N$ -dimensional channel symbols, $N > 1$, and wherein said means for interleaving causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

4. The apparatus of claim 2 wherein said channel symbols are $2N$ -dimensional channel symbols, $N > 1$, and wherein said means for interleaving causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

5. A modem comprising

means for receiving a stream of input bits,

means for dividing said stream of input bits into a stream of uncoded bits and a plurality of streams of trellis bits,

means for independently trellis encoding each of said plurality of streams of trellis bits to generate respective streams of data words each identifying one of a plurality of predetermined subsets of the channel symbols of a predetermined $2N$ -dimensional constellation, N being an integer greater than unity, each of said channel symbols being comprised of a plurality of signal points,

means for selecting an individual channel symbol from each identified subset in response to said stream of uncoded bits to form a stream of channel symbols, and

means for generating a stream of output signal points, said signal point stream being comprised of the signal points of the selected channel symbols, the signal points of said signal point stream being sequenced in such a way that signal points that are either a) part of the same channel symbol, or b) part of channel symbols that are adjacent to one another in said channel symbol stream, are separated in said output stream by at least one other signal point.

6. The apparatus of claim 5 wherein said trellis encoding means includes a plurality of trellis encoder stage

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11

means for trellis encoding respective ones of said streams of trellis bits.

7. The apparatus of claim 5 wherein said means for selecting includes means for modulus converting said stream of uncoded bits.

8. The apparatus of claim 5 wherein said channel symbols are $2N$ -dimensional channel symbols, $N > 1$, and wherein said means for generating causes every N^{th} signal point in said stream of output signal points to be the N^{th} signal point of a respective one of said channel symbols.

9. Receiver apparatus for recovering information from a received stream of trellis encoded signal points, said signal points having been transmitted to said receiver apparatus by transmitter apparatus which generates said signal points by generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said information, each of said channel symbols being comprised of a plurality of signal points, and by interleaving the signal points of said generated channel symbols to form said stream of trellis encoded signal points, said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points,

said receiver apparatus comprising

means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols, and

a distributed Viterbi decoder for recovering said information from the deinterleaved signal points.

10. The apparatus of claim 9 further comprising a phase tracking loop, and means for adapting the operation of said phase tracking loop in response to minimum accumulated path metrics in said distributed Viterbi decoder.

11. A method for forming a stream of trellis encoded signal points in response to input information, said method comprising the steps of

generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said input information, each of said channel symbols being comprised of a plurality of signal points, and

interleaving the signal points of said generated channel symbols to form said stream of trellis encoded signal points, said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points.

12. The method of claim 11 wherein said generating step generates three of said streams of trellis encoded channel symbols, and wherein said interleaving step causes there to be interleaved between each of the signal points of each channel symbol at least two signal points from other channel symbols of said streams of trellis encoded channel symbols.

13. The method of claim 11 wherein said channel symbols are $2N$ -dimensional channel symbols, $N > 1$, and wherein said interleaving step causes every N^{th} signal point in said interleaved signal point stream to be

12

the N^{th} signal point of a respective one of said channel symbols.

14. The method of claim 12 wherein said channel symbols are $2N$ -dimensional channel symbols, $N > 1$, and wherein said interleaving step causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

15. A method for use in a modem, said method comprising the steps of

receiving a stream of input bits,

dividing said stream of input bits into a stream of uncoded bits and a plurality of streams of trellis bits,

independently trellis encoding each of said plurality of streams of trellis bits to generate respective streams of data words each identifying one of a plurality of predetermined subsets of the channel symbols of a predetermined $2N$ -dimensional constellation, N being an integer greater than unity, each of said channel symbols being comprised of a plurality of signal points,

selecting an individual channel symbol from each identified subset in response to said stream of uncoded bits to form a stream of channel symbols, and

generating a stream of output signal points, said signal point stream being comprised of the signal points of the selected channel symbols, the signal points of said signal point stream being sequenced in such a way that signal points that are either a) part of the same channel symbol, or b) part of channel symbols that are adjacent to one another in said channel symbol stream, are separated in said output stream by at least one other signal point.

16. The method of claim 15 wherein in said trellis encoding step a plurality of trellis encoder stages trellis encode respective ones of said streams of trellis bits.

17. The method of claim 15 wherein said selecting step includes the step of modulus converting said stream of uncoded bits.

18. The method of claim 15 wherein said channel symbols are $2N$ -dimensional channel symbols, $N > 1$, and wherein said generating step causes every N^{th} signal point in said stream of output signal points to be the N^{th} signal point of a respective one of said channel symbols.

19. A method for use in a receiver to recover information from a received stream of trellis encoded signal points, said signal points having been transmitted to said receiver apparatus by a method which includes the steps of

generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said information, each of said channel symbols being comprised of a plurality of signal points, and interleaving the signal points of said generated channel symbols to form said stream of trellis encoded signal points, said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points,

said method comprising the steps of

deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols, and

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13

using a distributed Viterbi decoder to recover said information from the deinterleaved signal points.

20. The method of claim 19 wherein said receiver includes a phase tracking loop and wherein said method comprises the further step of adapting the operation of said phase tracking loop in response to minimum accumulated path metrics in said distributed Viterbi decoder.

21. Data communication apparatus comprising

means for receiving input information,

means for generating a plurality of streams of trellis encoded channel symbols in response to respective portions of said input information, each of said channel symbols being comprised of a plurality of signal points,

means for interleaving the signal points of said generated channel symbols to form a stream of trellis encoded signal points, said interleaving being carried out in such a way that the signal points of each channel symbol are non-adjacent in said stream of trellis encoded signal points and such that the signal points of adjacent symbols in any one of said channel symbol streams are non-adjacent in said stream of trellis encoded signal points,

means for applying the stream of trellis encoded signal points to a transmission channel,

14

means for receiving the stream of trellis encoded signal points from the channel,

means for deinterleaving the interleaved signal points to recover said plurality of streams of trellis encoded channel symbols, and

a distributed Viterbi decoder for recovering said information from the deinterleaved signal points.

22. The apparatus of claim 21 wherein said means for generating generates three of said streams of trellis encoded channel symbols, and wherein said means for interleaving causes there to be interleaved between each of the signal points of each channel symbol at least two signal points from other channel symbols of said streams of trellis encoded channel symbols.

23. The apparatus of claim 21 wherein said channel symbols are $2N$ -dimensional channel symbols, $N > 1$, and wherein said means for interleaving causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

24. The apparatus of claim 22 wherein said channel symbols are $2N$ -dimensional channel symbols, $N > 1$, and wherein said means for interleaving causes every N^{th} signal point in said interleaved signal point stream to be the N^{th} signal point of a respective one of said channel symbols.

* * * * *

30

35

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50

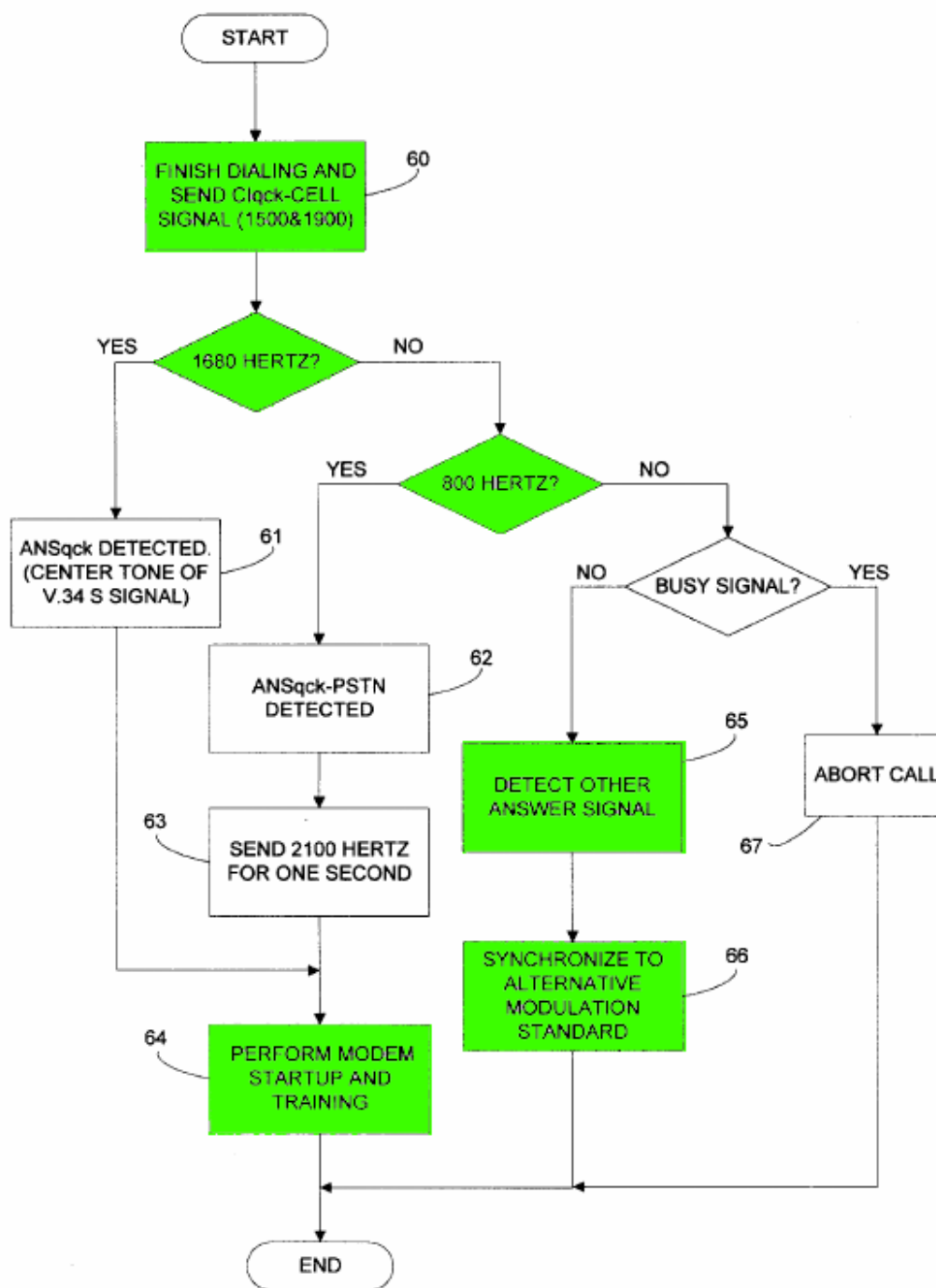
55

60

65

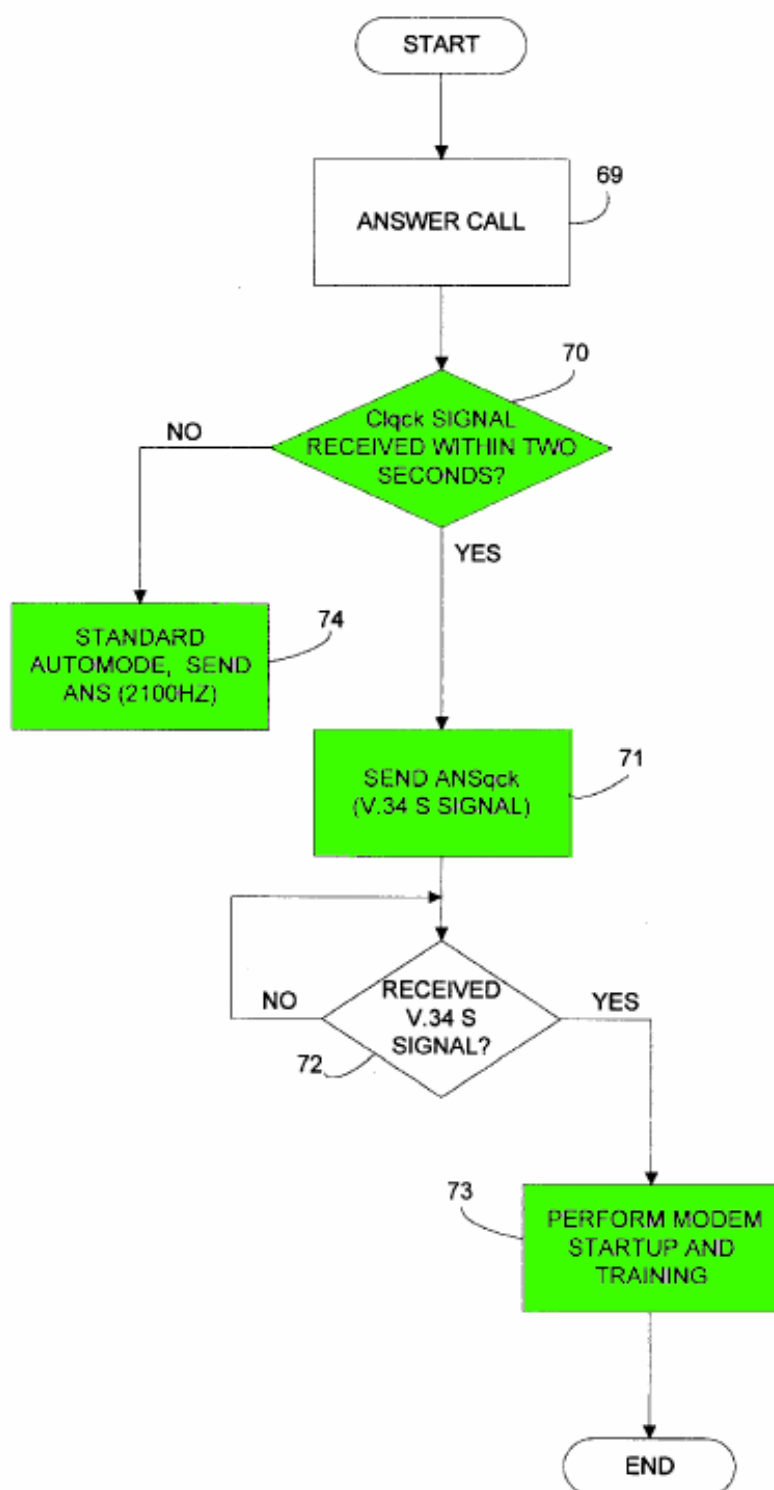
Exhibit 5

EXHIBIT 5-A

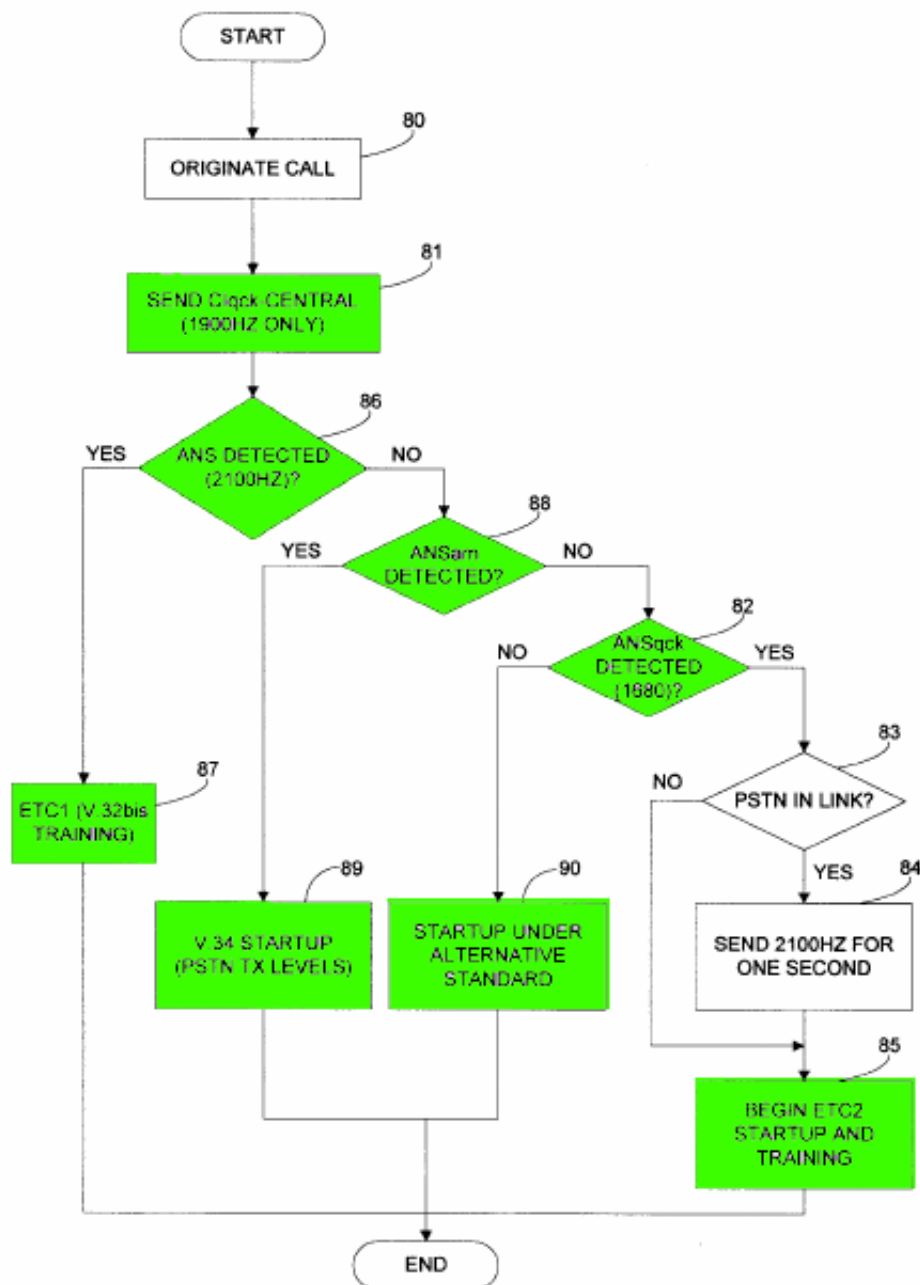


Calling Modem -- Cellular
FIG. 4

EXHIBIT 5-B

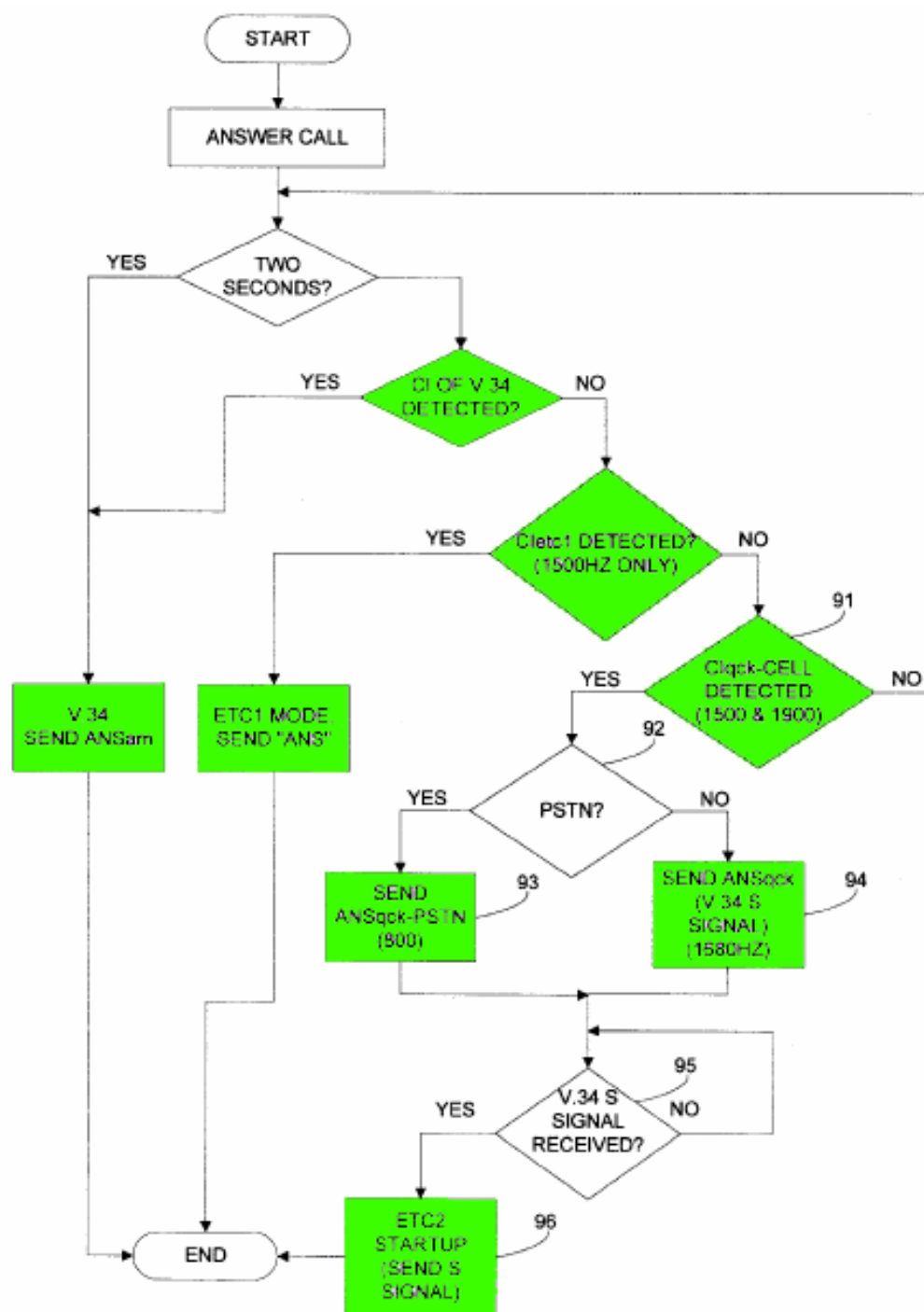


Answer Modem -- Cellular
FIG. 5

EXHIBIT 5-C

Calling Modem -- Central Site

FIG. 6

EXHIBIT 5-D

Answer Modem -- Central Site
FIG. 7

Exhibit 6

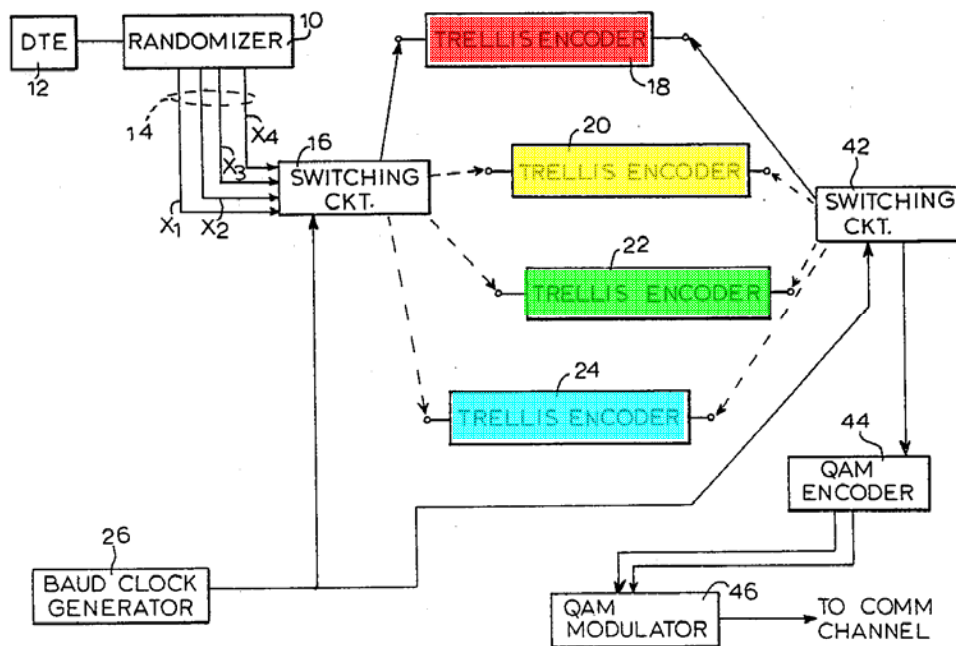
EXHIBIT 6-A

EXHIBIT 6-B

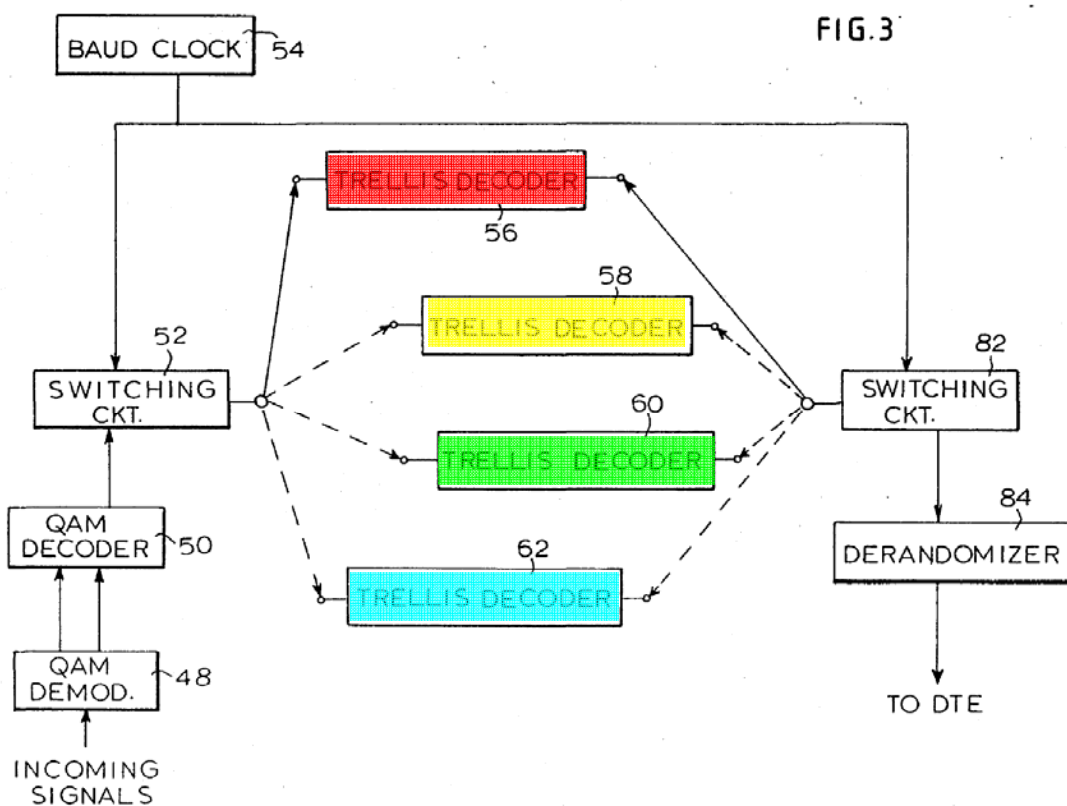


EXHIBIT 6-C

TE18/ VD56	TE20/ VD58	TE22/ VD60	TE24/ VD62	TE18/ VD56	TE20/ VD58	TE22/ VD60	TE24/ VD62	• • •	TE18/ VD56	TE20/ VD58	TE22/ VD60	TE24/ VD62
---------------	---------------	---------------	---------------	---------------	---------------	---------------	---------------	-------	---------------	---------------	---------------	---------------

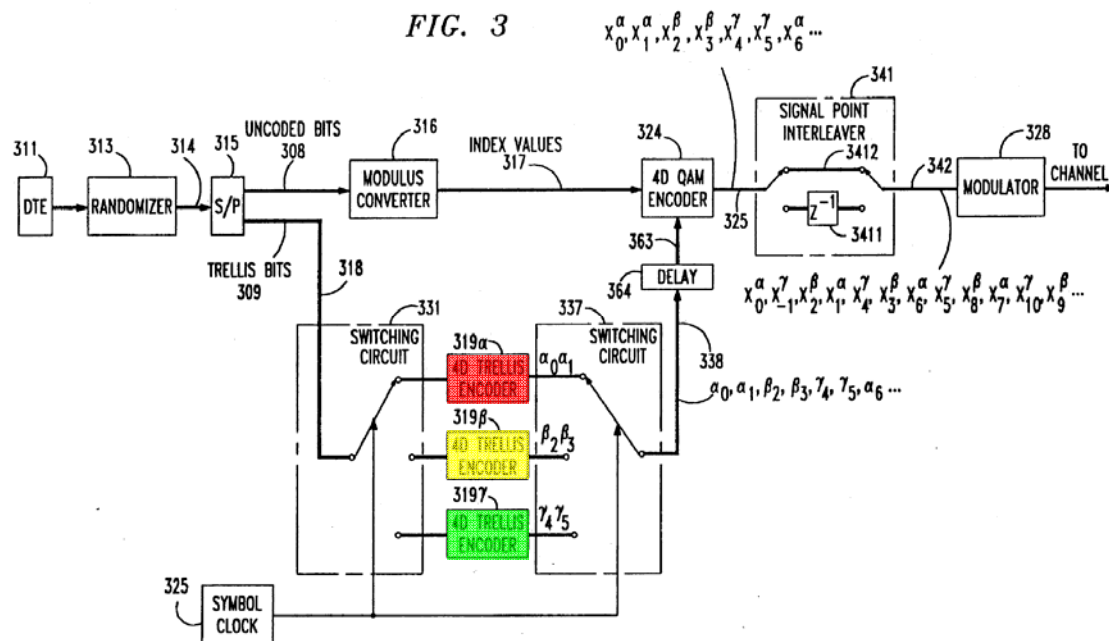
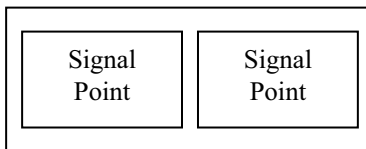
EXHIBIT 6-D**FIG. 3**

EXHIBIT 6-E



Trellis Encoded Channel Symbol

EXHIBIT 6-F

X_0^a	X_1^a	X_2^β	X_3^β	X_4^γ	X_5^γ	X_6^a	X_7^a	X_8^β	X_9^β	X_{10}^γ	...
---------	---------	-------------	-------------	--------------	--------------	---------	---------	-------------	-------------	-----------------	-----

X_0^a	$X_{(-1)}^\gamma$	X_2^β	X_1^a	X_4^γ	X_3^β	X_6^a	X_5^γ	X_8^β	X_7^a	X_{10}^γ	...
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Exhibit 7

1 {CITY}, California, {DAY}, {DATE}

2 {TIMES}

3

4 SILLER,

5 having been first duly sworn, was examined and testified

6 as follows:

7

8 EXAMINATION

9 BY {ATTY}:

10

11 {(Plaintiffs/Defendants)Exhibit No. {#} was

12 marked for identification.)

13 THE VIDEOGRAPHER: Good morning. Here begins

14 videotape number 1 in the deposition of the Curtis

15 Siller in the matter of Rembrandt versus Comcast in the

16 united states district court for the eastern district of

17 the Texas Marshall division Case No. 205-CV-0 0 443-D J

18 W. Today's date is December 20th 2006 the time is 927

19 A.M.

20 This deposition being taken at 710 Sansome

21 Street San Francisco, California. The videographer

22 March Marjoub here on behalf of Esquire Deposition

23 Services 505 Sansome suite 502 San Francisco,

24 California.

25 Will counsel please identify yourself and

1 MR. WERDEGAR: Objection form.

2 THE DEPONENT: It's.

3 MR. DEVLIN: I sorry the part -- start the
4 part on the left is the packet channel.

5 A Understood you to have.

6 Q Let me just say it all again clearly?

7 A Okay.

8 Q Start from the start.

9 Looking at that dotted line middle of figure 5
10 it divide into two regions right?

11 A Correct.

12 Q The region on the left is the channel for
13 packets sources?

14 MR. WERDEGAR: Objection form is that fair.

15 A Yes.

16 Q And the region on the right or the Charles for
17 the synchronous sour he's?

18 MR. WERDEGAR: Objection form.

19 THE DEPONENT: Not labeled as such inferred
20 that to be the case.

21 Q There are time slots shown on the left hand
22 side of the figure?

23 A Right.

24 Q What are those?

25 A .

1 MR. WERDEGAR: Objection. Form.

2 THE DEPONENT: Those are individual time slots
3 fix in size that make up a portion of the part of the
4 overall frame that is set aside for packet
5 communications.

6 Q On the right-hand side of the figure it
7 doesn't actually say the word time slot do you see
8 that?

9 A Yes I see that.

10 Q Based on your understanding and reading of the
11 entire patent is it your understanding that those time
12 slots exist on the right-hand side of the figure also?

13 A That would be my understanding.

14 Q They are just shown in figure 5?

15 MR. WERDEGAR: Objection. Form.

16 MR. WERDEGAR: Is that fair.

17 A That's fair.

18 Q There's a Designation that start of packet 50
19 do you see that?

20 A I do.

21 Q And that starts thick bold line that starts on
22 frame 1 ends at that dotted line and then continues on
23 the left-hand side of frames 2 and 3 continues into
24 frame 4 again on the left hand side and then ends do you
25 see that?

1 after the one that's shown?

2 MR. WERDEGAR: Objection. Form.

3 THE DEPONENT: Not from figure 5.

4 Q If you knew from the text of the patent this
5 is a hypothetical if the next of the patent told you
6 which of the packet data sources was transmitting that
7 packet?

8 A Uh-huh.

9 Q In figure 5?

10 A Yes.

11 Q Could you tell me then what the next packet
12 source would be to transmit a packet?

13 MR. WERDEGAR: Objection. Form.

14 THE DEPONENT: I could not.

15 Q Why is that?

16 A Because the very next one may not have any
17 information to send.

18 Q And if it doesn't what would happen?

19 A It would go to the next one.

20 Q So there's no particular order in which the
21 packet data sources have to transmit data in the 858
22 patent invention?

23 MR. WERDEGAR: Objection. Form.

24 THE DEPONENT: I believe this is the

25 description of sequence process in which there is a se

1 again tail arbitration to invite the individual packet
2 modules to transmit.

3 Q Let me see if I answer this is foundational
4 question. There's --

5 A What is found.

6 Q There's no?

7 A What is foundational question.

8 Q I basic bit of information?

9 A Oh.

10 Q From you?

11 A Okay.

12 Q In 858 patent there's no actual sequence by
13 which the packet sources have to transmit their
14 information is that fair?

15 MR. WERDEGAR: Objection. Form.

16 THE DEPONENT: I think that's fair.

17 Q And what you are were saying before there's
18 some sequence of arbitration right?

19 A Yes.

20 Q But that arbitration doesn't mean that the
21 packet data sources will actually transmit in a given
22 sequence?

23 A .

24 MR. WERDEGAR: Objection form.

25 THE DEPONENT: That's right.

1 THE VIDEOGRAPHER: We are now back on the
2 video record the time is 1109 A.M.

3 Q Dr. Siller could you please turn to the 858
4 patent and let's look at column 11.

5 A Okay.

6 Q Do you see a paragraph beginning around line
7 18?

8 A Yes I do.

9 Q Reference to something called a synchronous
10 transfer mod ATM?

11 A That's right.

12 Q Do you understand what ATM is?

13 A Yes I do.

14 Q What is it?

15 A It's a packetization technique for carrying a
16 variety of traffic and most noted by the fact the
17 packets are fixed in size.

18 Q Why are they fixed in size?

19 A It was a compromise between the
20 telecommunication an the data industry at the particular
21 size of the packet used ATM with carry voice are well
22 suited to the P S T public switch telephone network
23 where as people working in the computer more inclined to
24 want to send packetized form so they compromised on a
25 size that meant the needs of telephone phoney and a fact

1 the packetization is used for data communications.

2 Q What do you mean telephone knee?

3 A Telephone calls.

4 Q There is a sentence that begins at a round
5 line 22 in the case of ATM do you see that?

6 A Yes in the case of ATM.

7 Q Yeah I will just it says in the case of A T M
8 cells the oxidants which form the cells need to be
9 aligned within D S O channels do you see that?

10 A I do.

11 Q Do you understand an understanding of what A T
12 M cell is?

13 A Yes I do.

14 Q That's that 48 bits were?

15 A Well it's actually 53 they are bites.

16 Q Bites thank you.

17 Is there anything else that makes up part of
18 ATM cell?

19 A Well it has two ingredients it has header it
20 has the information field part of the information field
21 can be given over to what they call the ATM adaptation
22 layer.

23 Q What is in the header?

24 A The header would contain addressing
25 information yeah addressing information.

1 Q Anything else?

2 A It may indicate the fact what type of A.A.A. T
3 M adaptation layer is being used there are 5 AA L
4 through AA L5.

5 Q Okay. Are ATM when you are using an
6 synchronous transfer mode network?

7 A Uh-huh.

8 Q Are ATM cells used for both the packetized
9 data and for telephone phoney?

10 MR. WERDEGAR: Objection form.

11 Q Would you?

12 Q Simpler one. ATM cells used for telephone
13 phoney applications in ATM networks?

14 MR. WERDEGAR: O. Form.

15 THE DEPONENT: Yes they are.

16 Q That sentence continues to say the objecting
17 sits which form the cells need to be add lined within D
18 S O channels do you see?

19 A I do.

20 Q Oxidants I am saying that right?

21 A Yeah you are saying that right.

22 MR. WERDEGAR: Objection form.

23 Q What does it mean by objects?

24 A Well the a bits make up an objecting diet so
25 another phrase for byte is objecting diet.

1 MR. WERDEGAR: Objection. Form.

2 THE DEPONENT: I'm not sure I have an expert
3 opinion on that.

4 Q Okay. In any case there's nothing in that
5 phrase that we just read or anything else that can think
6 of that states that the network timing means actually
7 does that division right?

8 A Right.

9 Q Okay.

10 A In fact I believe that the structure that is
11 counterpart to the patent claim terms you had me read.

12 Q When structure now let's talk about that.
13 I'm looking at the chart again I am sorry?

14 A That's sorry.

15 Q This A 23 to A 24 on A 24 you see the
16 structure?

17 A Fine.

18 Q Right?

19 A Okay.

20 Q Structure designate the network timing control
21 processor 12 right?

22 A Correct.

23 Q You provide citations there.

24 A Yeah.

25 Q Can you this what exactly is the structure

1 Q I'm with you there but I'm asking you so let's
2 just start at the start again?

3 A Okay.

4 Q This text doesn't specify that this
5 transmission from the master unit to each of respect
6 remote units is performed by the ranging means right?

7 A That's correct.

8 Q Okay. The master unit includes the ranging
9 means?

10 A It does.

11 Q But there's other things in the master unit
12 also right?

13 A That's right.

14 Q Okay it could be something else in the master
15 unit that perform that transmission function?

16 MR. WERDEGAR: Objection leading form.

17 Q Is that fair?

18 A Yes that's fair.

19 Q Okay. Let's talk now about the function that
20 you layout -- let back back up for a second apart from
21 claim language we just been discussing is there any else
22 in patent so we talking about the bass your opinion this
23 is in fact subject to 112, 6?

24 A That's light.

25 Q Claim range we talked about it right?

1 A Okay. Would you pose the question.

2 Q Sure what figure out is so the application
3 program are assigned time slots to descend information
4 right?

5 A .

6 MR. WERDEGAR: objection leading form beyond
7 the scope.

8 THE DEPONENT: Application programs that are
9 assigned to a time slot is that your question.

10 Q Close. Let try rephrase?

11 MR. WERDEGAR: actually form any opinions sit
12 you don't have that's fine.

13 THE DEPONENT: Yeah this is too conform an
14 opinion right now.

15 Q So you have actually reviewed claim 1 is that
16 what you are saying?

17 A .

18 MR. WERDEGAR: objection form leading.

19 THE DEPONENT: I think I was ask to testify
20 certain ellengths of claim number 1.

21 Q Sure?

22 A I have formed an opinion on every aspect.

23 Q Okay. You do agree with me though that the
24 description of the patent indicated that time slots
25 could be assigned dynamically?

1 MR. WERDEGAR: objection. Form leading beyond
2 the scope.

3 THE DEPONENT: I have read that in the
4 description.

5 Q Let me just make sure we are on the same page
6 what we read in the description at column 2 lines 18
7 through 26 do you see that?

8 A Yeah.

9 Q Indicates to you that time slots can be assign
10 dynamically is the fair?

11 MR. WERDEGAR: objection form leading beyond
12 the scope of the expert designation.

13 THE DEPONENT: Well master unit going to make
14 a decision as to whether or not the requesting remote
15 unit should use additional access slots it doesn't say
16 that they allocated to them but.

17 Q Remote does decide that the requesting unit
18 get they are going assign dynamically correct?

19 MR. WERDEGAR: objection form leading beyond
20 the copy of expert designation.

21 THE DEPONENT: They assign on the basis of
22 priority information and that may not be a dynamic
23 judgment priority could be done at initialization.

24 Q But that request -- let me just read through
25 let me just note tore the record that the objections are

1 Q And could you give me example of that?

2 A I don't think of a specific example I think
3 more words are sufficient you have to data communication
4 flows as a decision made somehow one as a high he
5 relevant prior toe than another and that's that.

6 Q What be possible one type of application data
7 social tiff one type of application to be granted a
8 higher priority that data associated with another
9 application would that be possible?

10 MR. WERDEGAR: objection form.

11 THE DEPONENT: Yes I think that would be
12 possible.

13 Q Were you dealing with any issues of priority
14 in the late 1980s or early 1990s when this patent was in
15 the patent office and when it was filed?

16 MR. WERDEGAR: objection. Form.

17 THE DEPONENT: No I don't think I was.

18 Q You personally you weren't?

19 A That's correct.

20 Q Okay do you think it would have been within
21 the skill of someone in the field to be able to assign
22 priority based on one application versus another at that
23 time in 1989?

24 MR. WERDEGAR: objection. Form.

25 THE DEPONENT: Within my profession experience

1 associated with that application number 1 to say that I
2 set them or whomever would set them is not divulged
3 here.

4 Q Let me confirm what you said. This figure
5 indicates that there can be priority bits associated
6 with that application one is that fair reading of it?

7 MR. WERDEGAR: objecting form objection
8 leading beyond the scope.

9 THE DEPONENT: Yes.

10 Q And then you could also have priority bits
11 associated with application two right?

12 MR. WERDEGAR: same objections.

13 THE DEPONENT: Yes.

14 Q And you could have excuse me have priority
15 bits associated with application N?

16 MR. WERDEGAR: same objections.

17 THE DEPONENT: Yes.

18 Q And those prior bits could be different
19 between application two and application two is that
20 fair?

21 MR. WERDEGAR: objection leading objection
22 form [TKWROPBD] the scope.

23 THE DEPONENT: Depend on how many bits are
24 that make up the priority it's only one only would be
25 two.

Exhibit 8

page 6

1 1 [!CITY, STATE], [!BEGIN DAY], [!BEGIN DATE]

2 2 [!BEGIN TIME] - [!END TIME]

3 THIS IS A REALTIME ROUGH DRAFT TRANSCRIPT. IT
4 IS NOT CERTIFIED BY THE CERTIFIED SHORTHAND REPORTER AND
5 CANNOT BE OFFERED AS THE OFFICIAL CERTIFIED TRANSCRIPT
6 OF THESE PROCEEDINGS. IT CANNOT BE CITED FROM OR USED
7 IN ANY WAY TO REBUT OR CONTRADICT THE OFFICIAL CERTIFIED
8 SHORTHAND REPORTER. IT IS PROVIDED FOR THE INTERNAL USE
9 OF THE CLIENT TO WHICH IT IS PROVIDED.

10 HARRY BIMS, Ph.D.,

11 having been first duly sworn, was examined and testified
12 as follows:

13 THE VIDEOGRAPHER: Good morning, here begins
14 Videotape No. 1, in the deposition of Harry Bims, in the
15 matter of Rembrandt versus Comcast in the United States
16 District Court for the eastern district of the Texas as
17 marshal division case number 205 dash CV dash 00443 dash
18 TJW, today's date is December 22nd, 2006, the time is
19 8:56 a.m., this deposition is being taken at 710 Sansome
20 Street, San Francisco California, the videographer is
21 Marty Majdoub here on /PHRAF of Esquire Deposition
22 Services 505 Sansome Suite 502, San Francisco

page 77

1 A Well the error correction code itself does not
2 correct data bits. It simply provides the information
3 that is useful for the eventually correction of those
4 error bits.

5 Q Well something on the receiver that is a
6 Reed-Solomon decoder does that; right?

7 A Yeah the purpose of the Reed-Solomon decoder
8 would be to take advantages of the extra information
9 provided by a Reed-Solomon encoder for the purposes of
10 correcting error bits.

11 Q And isn't it the case that in a Reed-Solomon
12 decoder errors are corrected typically on a bitwise
13 basis?

14 MR. WERDEGAR: Objection. Form.

15 THE WITNESS: Yeah, I would say that there are
16 a variety of implementations for a Reed-Solomon decoder,
17 and that you do not necessarily have to decode
18 Reed-Solomon code words on a /PWAO*EUT by /PWAO*EUT base
19 /STKPHREUS what's Reed-Solomon code word.

20 THE WITNESS: A Reed-Solomon code word is a can
21 cat nation of bits generated from a Reed-Solomon
22 encoder.

23 Q And what is the significance of the size of the
24 Reed-Solomon code word?

25 MR. WERDEGAR: Objection. Form.

page 101

1 well?

2 A

3 MR. WERDEGAR: Objection. Form.

4 THE WITNESS: I'm not necessarily opposed to
5 this paragraph as written.

6 BY MR. KOLODNEY:

7 Q Okay so --

8 A But I do believe that again, there are other
9 elements that are not mentioned in this paragraph that I
10 would include in the definition.

11 Q Okay. So you agree that as presently
12 understood, and as understood in the 1990s, the physical
13 layer included at least the mechanical electrical
14 functional and procedural characteristics to establish,
15 maintain and release physical connections EG, data
16 circuits, between data link entities?

17 MR. WERDEGAR: Objection form.

18 BY MR. KOLODNEY:

19 Q Would you agree with that?

20 MR. WERDEGAR: Objection. Form. Objection.
21 Leading.

22 THE WITNESS: Yeah, I would say that at at
23 least those elements would be included in the physical
24 layer.

25 BY MR. KOLODNEY:

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1 led to this patent was something that you agreed with in
2 1998 when you filed it.

3 A Yes, I believe that the invention was the --
4 was something I agreed with, yes.

5 Q And the description of how the invention worked
6 in this patent was accurate, was it not?

7 A Of how the I /SREPBGS worked, yes.

8 Q (Invention worked)?

9 Q I'd like you to turn your attention to column
10 8, line 5?

11 A Okay.

12 Q And read for me the first two sentences --
13 first three sentences of that paragraph?

14 A It says data link layer, layer to 408 looks the
15 same for all protocols. In one embodied /PHEPT, data
16 link layer 408 is implemented for inbound channels in
17 the vice driver 304 with Reed-Solomon decoding of the
18 inbound data packets. Checks on verification an packet
19 identification.

20 Q Dr. Bims, did you or did you not in the 911
21 patent describe the data link layer as including
22 Reed-Solomon decoding of inbound packets?

23 MR. WERDEGAR: Objection. Form. Objection.
24 Leading.

25 THE WITNESS: What I said here, and I'm looking

page 112

1 word for word at what is written in this specification,
2 is that in one embodiment, it is possible to do
3 Reed-Solomon decoding of inbound packets, add in a data
4 link packet in that embodiment.

5 BY MR. KOLODNEY:

6 Q So in the embodiment you were describing in
7 this paragraph, in your patent, you describe the data
8 link layer as including the Reed-Solomon decoding of
9 inbound packets, did you not?

10 MR. WERDEGAR: Objection. Form, objection
11 leading. And if you need.

12 THE WITNESS: I haven't read the patent.

13 MR. WERDEGAR: If you need to take time if you
14 want to review the patent before answering the question
15 you should feel welcome to refresh yourself.

16 THE WITNESS: Okay, I mean, just grab a
17 sentence here, it's been what, 6 -- 5 years or -- when
18 did I submit it, 8 years ago. So I know that that text
19 that we just read refers to figures that are elsewhere
20 in the specification and.

21 Q Well, I'll tell you what, you read this, and
22 tell me when you've read enough of it to explain the 3
23 sentences that we just read into the record, please.
24 Take as much time as you need.

25 A Okay.

page 113

1 Q All right.

2 A Um-hmm.

3 Q So first of all, the data link layer that's
4 referred to in column 8 of your patent is the data link
5 layer of the OSI model; right?

6 A Yes.

7 Q That's what it says in the previous column?

8 A Right.

9 Q Okay? And the thing you're describing in
10 column 8 is elements of a receiver; right?

11 A Um-hmm.

12 Q And the receiver in layer 2 in the data link
13 layer is using a Reed-Solomon decoder?

14 A Um-hmm.

15 Q To decode packets that have been coded by the
16 transmitter using a Reed-Solomon code?

17 MR. WERDEGAR: Objection to form.

18 BY MR. KOLODNEY:

19 Q Right?

20 MR. WERDEGAR: Objection form. Objection
21 leading.

22 THE WITNESS: It doesn't actually say that in
23 the specification. I think here we're just focusing on
24 the receiver.

25 BY MR. KOLODNEY:

page 133

1 sources that I would use.

2 Q Okay.

3 MR. WERDEGAR: It does seem like we're moving
4 into a new area you /TKOPT think it's an appropriate
5 time to take a lunch break.

6 MR. KOLODNEY: Sure.

7 MR. WERDEGAR: Thanks.

8 MR. KOLODNEY:

9 THE VIDEOGRAPHER: We're now going off the
10 video record. The time is 12:29 p.m.

11 (Lunch recess taken from [!LUNCH TIME] to
12 [!RETURN TIME].)

13 THE VIDEOGRAPHER: We are now back on the
14 individual wrote record. The time is 1:31 p.m.
15 BY MR. KOLODNEY:

16 Q Dr. Bims, was the purpose of the Reed-Solomon
17 decoder in your 911 patent to detect and correct errors
18 that can occur in the physical layer?

19 A Yes.

20 Q And you mentioned that some of your earlier
21 work involved development of trellis codes; is that
22 correct?

23 A Yes.

24 Q And was the purpose of the trellis codes that
25 you developed to detect and correct errors that could

page 144

1 A

2 MR. WERDEGAR: Objection. Form.

3 THE WITNESS: (What's).

4 THE WITNESS: FEC code is a Ford error
5 correction code.

6 Q And what are some examples of forwarder or
7 correction code?

8 A I would say forwarder or correction codes would
9 be, say, a hamming code /(.

10 Q How about a Reed-Solomon code?

11 A Yeah BCH codes, Reed-Solomon codes would be FEC
12 codes.

13 Q Would a trellis code be a FEC code?

14 A Yeah, I would say so.

15 Q Okay. And what you just read in the /AB tract
16 is a description of using a block forwarder or
17 correction code in the data link layer for correcting
18 bitter ors is is that not the case?

19 A That's.

20 MR. WERDEGAR: Objection. Objection. Form,
21 objection leading.

22 THE WITNESS: Yes, that's true.

23 BY MR. KOLODNEY:

24 Q So whatever you think link layer means, the
25 authors of this article clearly understood error

page 181

1 accurate one.

2 Q Okay. Let me then rephrase it and say would
3 you agree that a negotiated physical modulation is
4 selected by a method permitting two modems supporting
5 different physical layer modulations to agree on a
6 physical layer modulation?

7 A Well, again I guess that's truncated recitation
8 of the fullness of the construction.

9 Q Well would you agree that it's accurate as far
10 as it goes?

11 A I would agree it's an abbreviation of the
12 correct definition.

13 Q Okay. And what if I added to that that one
14 modem has to present one or more options to the other
15 modem and the other modem has to choose from among the
16 presented options which ones it wants to use, would that
17 be correct?

18 A Well, again, as was stated here on -- in
19 this -- in the file history on page 6, the answering
20 modem has to be incapable of execute theing command
21 presented to it by the calling modem for there to be
22 negotiation and then secondly, this has to take place at
23 run time.

24 Q Okay. And would you agree that if the two
25 modems did not support all the same physical layer

page 227

1 THE WITNESS: Yeah, I don't believe I've made
2 that conclusion.

3 BY MR. KOLODNEY:

4 Q No, but you've said that although the
5 structures that are specified here or not all necessary
6 to perform the functions, somewhere in this litany of
7 structures we can find the necessary structure. That's
8 what you're saying, isn't it?

9 A No, I'm not saying that.

10 Q Well, you are saying that what's listed here is
11 more than is necessary to perform the recited function;
12 right?

13 A Yeah, I could for example I've already said
14 that I could for example eliminate Figure 8 from what I
15 believe are the absolutely required structural elements.

16 Q How about Figure 9?

17 A Within Figure 9, I would specifically point out
18 on Figure 9 itself the structural elements 114, 124,
19 120, and 124.

20 Q And what about those structural elements would
21 you point out?

22 A What about them? /STKPHRU think those
23 structural elements are necessary to perform the
24 function.

25 A Yes.

page 228

1 Q Okay. And those are pieces of hardware, right?

2 A Yes.

3 Q Okay. Is there any hardware listed in figures
4 4 through 7?

5 A Let's see, figures 4 through 7, I believe, are
6 flow charts, yes, they are all flow charts.

7 Q Are all the steps in figures 4 through 7
8 necessary to perform the function of the means for
9 establishing a physical layer connection limitation?

10 A The way I would read this, figures 4 and 5 are
11 necessary structures for performing the function as a
12 collection, and then figures 6 and 7 are also
13 structures, alternate structures that perform the
14 function together, along with Figure 9 structures I
15 pointed out.

16 Q So it's not accurate to say then that you need
17 all of figures 4, 6, 7 and 9, in order to be the
18 corresponding structure to this limitation; right?

19 A Well, I guess my opinion here is that figures 4
20 and 5 in combination with the structural elements that I
21 outlined on Figure 9, represent the necessary structures
22 for performing the function, and figures 6 and 7 in
23 combination with the structural elements that I
24 mentioned before in Figure 9 would be also an alternate
25 set of instruction towers for performing the function.

page 234

1 answering modem, if the answering modem indeed generated
2 A and S QC K, the calling modem would not detect it
3 (ANS).

4 Q Okay?

5 A And in that case, I'm not sure what would
6 happen.

7 Q But if it generated something other than a 1680
8 Hertz response, it would be able to establish a
9 connection; right?

10 A The other parts of the flow chart would be
11 intact so.

12 Q And that would be a negotiated physical layer,
13 that would be a physical layer connection based on a
14 negotiated physical layer modulation; would it not?

15 MR. WERDEGAR: Objection form. Leading.

16 THE WITNESS: /TPH-FRPBLTS the scenario where
17 1680 Hertz question mark is false under that condition
18 then the rest of the flow chart would implement ant
19 negotiating a physical layer modulation.

20 Q So therefore element 61 is not necessary for
21 the establishment of a physical layer connection based
22 on a negotiated physical layer modulation; correct?

23 A One would not need 61 to do that.

24 Q Do you want to modify your position on what the
25 elements of figures 4 enthuse 7 are (through) that are

page 235

1 the corresponding structure to this limitation?

2 A Well it appears that in addition to the other
3 limitations that I put forth, that on Figure 4, that the
4 detection of ANS QC K would actually not be required to
5 perform a negotiated physical layer modulation.

6 Q Is that it?

7 A What I'm looking at Figure 5 (well I'm), Figure
8 5 is the answer modem flow chart. I would say that on
9 Figure 5, block 71, /STKPH is necessary or is not
10 necessary.

11 A Let me think clearly here.

12 A

13 Q In fact, this whole flow chart of Figure 5 only
14 happens if box 61 in Figure 4 happens on the
15 transmitting modem, isn't that the case?

16 A I wouldn't say that.

17 Q Well certainly box 71 corresponds to box 61,
18 doesn't it?

19 A

20 Q So if you're not going to do box 61, you're
21 also not going to do box 71 or 72 or 73 in Figure 5, so
22 those must be unnecessary as well to perform the
23 function in this limitation, isn't that right?

24 MR. WERDEGAR: Objection. Form. Leading.

25 MR. KOLODNEY: You know you keep saying

page 237

1 performing boxes 70 and 74 in Figure 5?

2 A You would have to implement box 69, I believe.

3 Q And 69?

4 A I would imagine in block 72 that a physical
5 layer modulation is never negotiated, if V dot 34 is
6 never received. So in that context, a physical layer
7 modulation it's possible would never get negotiated.

8 Q So the answer to my question, which is that the
9 only necessary structures in Figure 5 to perform the
10 establishing a physical layer connection between said
11 calling and said answer modems based on a negotiated
12 physical layer modulation is boxes 69, 70 and 74; is
13 that correct? If you perform those three steps, you can
14 perform the function required by that limitation of
15 claim 6?

16 A That's correct.

17 Q Okay. Now, turning to the next limitation,
18 in -- the next means limitation in claims 6 which is
19 means for establishing said link layer connection based
20 on said physical layer modulation, Comcast has
21 identified figures 8 to 9, column 12 line 55, to column
22 13 line 17, column 13, lines 34 to 41; column 13, line
23 55 to column 14, line 9. Do you agree with that
24 identification of structure corresponding to the means
25 for establishing said link layer limitation in claim 6?

page 238

1 A Again, I would, turning to these figures, the
2 structure that's performing this function of
3 establishing the link layer connection, would be in
4 Figure 9 --

5 Q I just asked you whether you agreed with what
6 is in Comcast's statement here about what the
7 corresponding structure is.

8 MR. WERDEGAR: And he was answering your
9 question, counselor, and I'd appreciate it if you
10 wouldn't interrupt the answer in mid answer.

11 Q I asked him if he agreed. I didn't ask him to
12 identify the structures which is what he was doing?

13 MR. WERDEGAR: You can ask him the question
14 again, but he's entitled to answer the question without
15 interrupting him.

16 MR. KOLODNEY: Do you or do you not agree with
17 the identification of structure that is contained on
18 page A 15 ***** of the joint claim construction
19 statement under the Comcast column.

20 THE WITNESS: I do believe the structures that
21 actually perform the function are contained what's
22 within identified.

23 Q So there's more identified by Comcast than is
24 actually necessary to perform the /TPUPGS; is that
25 correct?

page 239

1 A (Function).

2 A Yes.

3 Q Comcast's statement of structure doesn't
4 actually point out exactly which structures are
5 necessary to perform the function recited in the means
6 for establishing limitation of claim 6; is that right?

7 A The structures are there in what's listed
8 /STKPHREU know but the listing doesn't actually identify
9 which ones they are, does it.

10 A The structures, like I say, that actually
11 perform the function are a subset of what's listed
12 there.

13 Q But the subset is not identified on this list
14 is it?

15 MR. WERDEGAR: Objection. Form. Leading.

16 THE WITNESS: You don't see it called out
17 specifically.

18 BY MR. KOLODNEY:

19 Q So if someone reading this would not know
20 merely from reading it what structures you had in mind,
21 would they?

22 A

23 MR. WERDEGAR: Objection. Form. Leading.

24 THE WITNESS: Well, again, I guess this column
25 is Comcast's proposed constructions, you know, it wasn't

page 240

1 you know -- I gave my opinions but it wasn't my proposed
2 construction /STKPWHREUPL' not blaming you, but you
3 agree that what's written here is not what you believe
4 is actually the correct corresponding structure; right.

5 MR. WERDEGAR: Objection. Form. Leading.

6 THE WITNESS: I would just say that has' here
7 is more than what's actually performing the function.

8 Q

9 BY MR. KOLODNEY:

10 Q

11 THE VIDEOGRAPHER: Counsel, ten minutes.

12 MR. KOLODNEY: Okay.

13 Q Dr. Bims have you read the '627 patent and
14 understand what it discloses?

15 A Back to the '627. Yes I've read the '627
16 patent.

17 Q Do you understand the claim language in the
18 '627 patent?

19 MR. WERDEGAR: Objection. Form.

20 THE WITNESS: I have read through it.

21 Q Do you believe you understand it?

22 A

23 MR. WERDEGAR: Objection. Form.

24 THE WITNESS: From an engineer's perspective, I
25 have some understanding of what the claims are saying.

page 247

1 A A trellis encoder has changed its state because
2 the clock signal that's presented to it causes the
3 memory elements that comprise the state to clock -- to
4 sample and store a new value into it.

5 Q Okay. So in order for a trellis encoder to
6 output a value, there needs to be a estate change;
7 right?

8 A For each new value that is output from the
9 trellis encoder there needs to be a new state change.

10 Q Okay?

11 THE VIDEOGRAPHER: Counsel you have 2 minutes.

12 MR. KOLODNEY: Let's take a break.

13 THE VIDEOGRAPHER: Okay this is the end of
14 videotape number /#3-RBGS we are now going off the video
15 record. The time is 5:04 p.m. a.

16 (Interruption in the proceedings.)

17 THE VIDEOGRAPHER: This is the beginning of
18 Videotape No. 4, we are now back on the video record.
19 The time is 5:07 p.m.

20 BY MR. KOLODNEY:

21 Q So Dr. Bims, under your construction of trellis
22 encoded channel symbol, the trellis encoded channel
23 symbol cannot be generated from multiple outputs of a
24 trellis encoder; is that correct?

25 A

page 248

1 Q Multiple success if I have outputs of a trellis
2 encoder (successive)?

3 A A /TRET Is encoded channel symbol is from one
4 output of a trellis encode /STKPHRER under your
5 construction.

6 A Yes.

7 Q Of trellis encoder?

8 A Yes.

9 Q Now your construction of signal point is is a
10 single mapped point in a signal constellation; is that
11 your construction of signal point?

12 A Yes.

13 Q Can a single mapped point in a signal
14 constellation be a point in a one dimensional signal
15 constellation?

16 A Yes.

17 Q Are you familiar with VSB?

18 A Virginia /TEUPBLG gal side band.

19 Q Yes?

20 A Yes.

21 Q Does VSB have a one dimensional signal point
22 constellation?

23 A You can think of it in that context if you
24 /WABT.

25 Q That's an acceptable use of the term signal

page 249

1 point constellation?

2 A Yes.

3 Q *****?

4 Q Now, you've been identified as having an
5 opinion on the meaning of the -- sorry, I missed one.
6 Do you have an opinion about the meaning of distributed
7 by tour /PAOE decoder in the claims of the '627 patent?

8 MR. WERDEGAR: Objection beyond the scope of
9 the expert designation /(.

10 THE WITNESS: Well, the use of that term seemed
11 to vary, depending on where I saw it in the
12 specification.

13 Q Can you elaborate on that?

14 A There's the distributed /SRAB decoder singular,
15 referring to the collection of /(/SRAB decoders and
16 then there's the distributed /SRAB decoders /-RGS
17 referring to the individual /SRAB decoders themselves.

18 Q Well, when the claim talks about the receiver
19 having a distribute at the timed /SRAB decoder, for
20 recovering said information, what do you think it's
21 referring to there?

22 MR. WERDEGAR: Objection. Beyond the scope of
23 his expert designation.

24 THE WITNESS: I really wasn't even asked to
25 look into that.

page 254

1 Q Okay. Do you agree that you could implement
2 the /SRAB decoders described in this patent in a single
3 software program that through the use of indirect
4 addressing of multiple arrays within memory would serve
5 to provide the function of the multiple trellis encode
6 errs disclosed in Figure 4 of the patent?

7 MR. WERDEGAR: Objection. Beyond the scope of
8 his expert designation.

9 THE WITNESS:

10 BY MR. KOLODNEY:

11 Q Do you think that's within the skill of art?

12 A It's possible it's possible.

13 Q Is it within the skill of passenger of ordinary
14 skill in the art to do that?

15 A I'm sure a person of ordinary skill in the art,
16 if pressed could implement such a thing.

17 Q After reading this patent?

18 A Yes.

19 Q Okay. And there's certainly no ambiguity that
20 the patent is teaching that that's an alternative way to
21 implement the invention; right?

22 MR. WERDEGAR: Objection. Beyond the scope.
23 Leading, form.

24 THE WITNESS: I would say that this is an
25 embodiment of one way of implementing what it's talking

page 255

1 about here.

2 Q So implementing the /SRAB decoders, with a
3 single program routine is one embodiment of the
4 invention of the '627 patent; right?

5 A

6 MR. WERDEGAR: Objection. Beyond the scope.

7 THE WITNESS: At least that's what's presented
8 in this column.

9 BY MR. KOLODNEY:

10 Q Okay. Now, on the means for did he
11 interleaving limitation in claim 9 of the '627 patent,
12 if you turn to page A 5 of the I forget what exhibit
13 number it is, the first amended joint claim construction
14 pre hearing statement. What exhibit is that?

15 A 13.

16 Q 13, okay, look at page A 5 of Exhibit 13, you
17 see there the Comcast position on the function and
18 structure corresponding to the means for deinterleaving
19 limitation of claim 9?

20 A Yes.

21 Q And have you reviewed this prior to today?

22 A Yes, I have.

23 Q And did you agree that all of the structures
24 identified in by Comcast as being the /KOERPDing
25 structure are necessary to perform the function recited

page 256

1 in this means limitation?

2 A Well, there were some structural elements that
3 I thought were not absolutely required.

4 Q Which ones were those?

5 A Looking at block 431.

6 Q Um-hmm?

7 A Is not required for did he /SPW-R leaving of
8 the enter leave signal points.

9 Q Anything else?

10 A And that appears to be all.

11 Q What is deinterleaving mean?

12 A Deinterleaving means that it's a process that
13 reverses the process of interleaving.

14 Q

15 Q Would you agree that any structure that reverse
16 the interleaving process that was performed in the
17 transmitter, in Figure 3, would be sufficient to perform
18 the function of deinterleaving required by the means for
19 deinterleaving limitation of claim 9?

20 MR. WERDEGAR: Objection. Form. Leading.

21 THE WITNESS: Well, the claim 9 is talking
22 specifically about enter leave signal points so whatever
23 deinterleaving would have to be deinterleaving,
24 specifically the enter leave signal points.

25 Q So once again, here, you believe that Comcast

page 257

1 has identified more structure than was necessary to
2 perform the function recited in the claim, in the means
3 plus function claim limitation; is that correct?

4 A Yes.

5 Q

6 A I think I mentioned block 431.

7 Q Did you point that out to Comcast when you
8 reviewed this document the first time?

9 A I did mention to Comcast when I saw this joint
10 claim construction document, about block 431.

11 Q Did you review this document before it was
12 filed with the court?

13 A

14 Q On November 14th, 2006?

15 A I did look through it.

16 Q And did you /POEUP out to Comcast that they
17 identified too much structure as corresponding to the
18 means for deinterleaving in claim 9 of the '627 patent?

19 A I disclosed that to them after this document
20 was filed.

21 Q Well, why didn't you disclose it before it was
22 filed?

23 A When I read through this element, I think I
24 overlooked 431.

25 Q And similarly, with respect to the means

page 273

1 variety of elements here before the output 325.

2 BY MR. KOLODNEY:

3 Q Right. But each channel symbol on line 325
4 corresponds to that set of bits that are spit out by the
5 serial to parallel converter each time it's triggered by
6 the clock signal; right, by the symbol clock?

7 A It's a function of those 9 bits, among other
8 things, yes.

9 Q And on the receiving end the channel symbol is
10 decoded to restore those 9 bits to the output stream;
11 right?

12 A

13 Q The values on 414 and 463 if the system is
14 working properly should be the same as those 9 bits that
15 were spit out by the serial to parallel converter on the
16 transmitter side; right?

17 A Let's see, the stream 438 should correspond to.

18 A So I would say that 414 would correspond to 308
19 at the receiver and 463 would correspond to 318 -- 309.

20 Q 309 right. So in the whole point of this
21 system is that what you want, the output of Figure 4
22 should be the same as the input to Figure 3, that that's
23 the whole point of the system to receive on the
24 receiving end the stream of bits that were sent in on
25 the sending end; right?

Exhibit 9

The IEEE Standard Dictionary of Electrical and Electronics Terms

Sixth Edition

**Standards Coordinating Committee 10, Terms and Definitions
Jane Radatz, Chair**

This standard is one of a number of information technology dictionaries being developed by standards organizations accredited by the American National Standards Institute. This dictionary was developed under the sponsorship of voluntary standards organizations, using a consensus-based process.

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Introduction

Since the first edition in 1941 of the American Standard Definitions of Electrical Terms, the work now known as IEEE Std 100, The IEEE Standard Dictionary of Electrical and Electronics Terms, has evolved into the unique compendium of terms that it is today.

The current edition includes all terms defined in approved IEEE standards through December 1996. Terms are categorized by their technical subject area. They are also associated with the standards or publications in which they currently appear. In some cases, terms from withdrawn standards are included when no current source can be found. Earlier editions of IEEE Std 100 included terms from sources other than IEEE standards, such as technical journals, books, or conference proceedings. These terms have been maintained for the sake of consistency and their sources are listed with the standards in the back of the book.

The practice of defining terms varies from standard to standard. Many working groups that write standards prefer to work with existing definitions, while others choose to write their own. Thus terms may have several similar, although not identical, definitions. Definitions have been combined wherever it has been possible to do so by making only minor editorial changes. Otherwise, they have been left as written in the original standard.

Users of IEEE Std 100 occasionally comment on the surprising omission of a particular term commonly used in an electrical or electronics field. This occurs because the terms in IEEE Std 100 represent only those defined in the existing or past body of IEEE standards. To respond to this, some working groups obtain authorization to create a glossary of terms used in their field. All existing, approved standard glossaries have been incorporated into this edition of IEEE Std 100, including the most current glossaries of terms for computers and power engineering.

IEEE working groups are encouraged to refer to IEEE Std 100 when developing new or revised standards to avoid redundancy. They are also encouraged to investigate deficiencies in standard terms and create standard glossaries to alleviate them.

The sponsoring body for this document was Standards Coordinating Committee 10 on Definitions (SCC10), which consisted of the following members:

Jane Radatz, *Chair*

John W. Balde
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Bruce Barrow
William Carey
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Ralph M. Showers
Edward N. Skomal
Kenneth L. Swinth
Raymond S. Turgel
Edward F. Vance

the signal is synchronized by it. *See also*: oscillograph.

(IM) 748-1979w

synchronizing (1) (rotating machinery) The process whereby a synchronous machine, with its voltage and phase suitably adjusted, is paralleled with another synchronous machine or system. *See also*: asynchronous machine. (PE) [9]

(2) (facsimile) The maintenance of predetermined speed relations between the scanning spot and the recording spot within each scanning line. *See also*: facsimile.

(COM) 168-1956w

(3) (television) Maintaining two or more scanning processes in phase. (BT) [34]

(4) (pulse terminology) The process of rendering a first pulse train or other sequence of events synchronous with a second pulse train. (IM) 194-1977w

(5) (hydroelectric power plants) Process of paralleling and connecting a synchronous generator to another source.

(PE) 1020-1988r

synchronizing coefficient (rotating machinery) The quotient of the shaft power and the angular displacement of the rotor. *Note*: It is expressed in kilowatts per electrical radian. Unless otherwise stated, the value will be for rated voltage, load, power-factor, and frequency. *See also*: asynchronous machine. (PE) [9]

synchronizing or synchronism-check device (power system device function numbers) A device that operates when two ac circuits are within the desired limits of frequency, phase angle, and voltage, to permit or to cause the paralleling of these two circuits. (PE/SUB) C37.2-1979s

synchronizing reactor (power and distribution transformers) A current-limiting reactor for connecting momentarily across the open contacts of a circuit-interrupting device for synchronizing purposes. (PE) C57.12.80-1978r

synchronizing relay A programming relay whose function is to initiate the closing of a circuit breaker between two ac sources when the voltages of these two sources have a predetermined relationship of magnitude, phase angle, and frequency. (PE/SWG) C37.100-1992

synchronizing signal (1) (television) The signal employed for the synchronizing of scanning. *Note*: In television, this signal is composed of pulses at rates related to the line and field frequencies. The signal usually originates in a central synchronizing generator and is added to the combination of picture signal and blanking signal, comprising the output signal from the pickup equipment, to form the composite picture signal. In a television receiver, this signal is normally separated from the picture signal and is used to synchronize the deflection generators. (BT) [34]

(2) (facsimile) A signal used for maintenance of predetermined speed relations between the scanning spot and recording spot within each scanning line. *See also*: facsimile signal.

(COM) 168-1956w

(3) (oscillograph) A signal used to synchronize repetitive functions. *See also*: oscillograph. (IM) [40]

(4) (telecommunications) A special signal which may be sent to establish or maintain a fixed relationship in synchronous systems. (COM) [49]

synchronizing signal compression (television) The reduction in gain applied to the synchronizing signal over any part of its amplitude range with respect to the gain at a specified reference level. *Notes*: 1. The gain referred to in the definition is for a signal amplitude small in comparison with the total peak-to-peak composite picture signal involved. A quantitative evaluation of this effect can be obtained by a measurement of differential gain. 2. Frequently the gain at the level of the peaks of synchronizing pulses is reduced with respect to the gain at the levels near the bases of the synchronizing pulses. Under some conditions, the gain over the entire synchronizing signal region of the composite picture signal may be reduced with respect to the gain in the region of the picture signal. *See also*: television. (BT) [34]

synchronizing signal level (television) The level of the peaks of the synchronizing signal. *See also*: television.

(BT) [34]

synchronizing torque (synchronous machines) The torque produced, primarily through interaction between the armature currents and the flux produced by the field winding, tending to pull the machine into synchronism with a connected power system or with another synchronous machine. (PE) [9]

synchronous (1) A mode of transmission in which the sending and receiving terminal equipment are operating continuously at the same rate and are maintained in a desired phase relationship by an appropriate means. (COM) 1007-1991

(2) Protocol operation in which only one exchange between a given pair of entities can be handled at any moment in time. The current exchange must complete before the next can be initiated. (C/LM) 15802-2-1995

(3) Describes an activity specified by a function that is expected to be complete when the function returns.

(C/MM) 855-1990

synchronous booster converter A synchronous converter having a mechanically connected alternating-current reversible booster connected in series with the alternating-current supply circuit for the purpose of adjusting the output voltage. *See also*: converter. (EEC/PE) [119]

synchronous booster inverter An inverter having a mechanically connected reversible synchronous booster connected in series for the purpose of adjusting the output voltage. *See also*: converter. (EEC/PE) [119]

synchronous capacitor (rotating machinery) A synchronous machine running without mechanical load and supplying or absorbing reactive power to or from a power system. *See also*: converter; synchronous condenser. (PE) [9]

synchronous circuit A circuit in which clock pulses synchronize the operations of the elements. *Contrast*: asynchronous circuit. (C) 610.10-1994

synchronous communication *See*: synchronous transmission.

synchronous computer (1) A computer in which each event, or the performance of each operation, starts as a result of a signal generated by a clock. *Contrast*: asynchronous computer. (C) [20], [85], 610.10-1994

(2) A computer in which each event or operation is performed upon receipt of a signal generated by the completion of a previous event or operation, or upon availability of the system resources required by the event or operation.

(C) 610.10-1994

synchronous condenser* (1) (electric installations on shipboard) A synchronous phase modifier running without mechanical load, the field excitation of which may be varied so as to modify the power factor of the system; or through such modification, to influence the load voltage. (IA) 45-1983r

(2) A synchronous machine running without mechanical load and supplying or absorbing reactive power. *See also*: synchronous capacitor. (PE) [9]

* Deprecated.

synchronous converter (electric installations on shipboard) A converter which combines both motor and generator action in one armature winding and is excited by one magnetic field. It is normally used to change ac power to dc power.

(IA) 45-1983r

synchronous coupling (electric coupling) An electric coupling in which torque is transmitted by attraction between magnetic poles on both rotating members which revolve at the same speed. The magnetic poles may be produced by direct current excitation, permanent magnet excitation, or alternating current excitation, and those on one rotating member may be salient reluctance poles. (EM/PE) 290-1980w

synchronous detector A device whose output is proportional to the amplitude of a vector component of an input RF or IF signal measured with respect to an externally supplied reference signal. (AE) 686-1990w

synchronous device (data transmission) A device whose speed of operation is related to the rest of the system to which the device is connected. (PE) 599-1985w

Exhibit 10

IEEE Std 100-1992

**The New IEEE Standard Dictionary
of Electrical and Electronics Terms**
[Including Abstracts of All Current IEEE Standards]

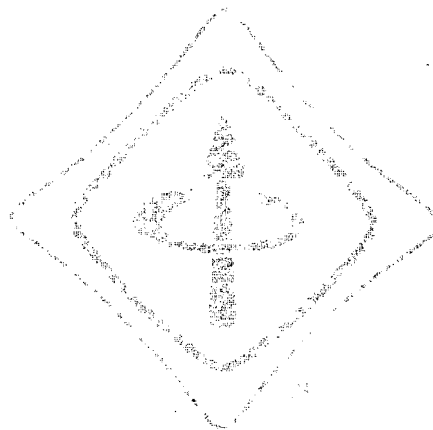
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IEEE

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January 15, 1993

SH15594

portable appliance may be connected by means of an attachment plug cap. [90]

appliance, portable (electric system). An appliance that is actually moved or can easily be moved from one place to another in normal use. See: **appliance**. [86]

appliance, stationary (electric system). An appliance that is not easily moved from one place to another in normal use. See: **appliance**. [86]

application (computer applications). The use to which a computer system is put; for example, a payroll application, an airline application, or a network application. 610.2-1987, 610.5-1990

application generator. A code generator that produces programs to solve one or more problems in a particular application area; for example, a payroll generator. 610.12-1990

application-oriented language (software). A computer language with facilities or notations applicable primarily to a single application area; for example, a language for computer-assisted instruction or hardware design. See also: **authoring language; specification language; query language; simulation language**. 610.12-1990

application program. A computer program that is used for a specific application. 610.5-1990

application software. Software designed to fulfill specific needs of a user; for example, software for navigation, payroll, or process control. Contrast with: **support software; system software**. 610.12-1990

application valve (brake application valve). An air valve through the medium of which brakes are automatically applied. [119]

application view. See: **logical database**. 610.5-1990

applicative order. A property of a programming language or procedure: the arguments to a procedure call are evaluated before the procedure is invoked, and the result of each evaluation is passed to the procedure in place of its argument expression. 1178-1990

applicator (electrodes) (dielectric heating). Appropriately shaped conducting surfaces between which is established an alternating electric field for the purpose of producing dielectric heating. 54-1955w

applied-fault protection (power switchgear). A protective method in which, as a result of relay action, a fault is intentionally applied at one point in an electrical system in order to cause fuse blowing or further relay action at another point in the system. C37.100-1981, C37.90-1978

applied-potential tests (electric power). Dielectric tests in which the test voltages are low-frequency alternating voltages from an

external source applied between conducting parts, and between conducting parts and ground. 32-1972

applied voltage (corona measurement). Voltage that is applied across insulation. Applied voltage may be between windings or from winding(s) to ground. 436-1977

applied voltage tests (power and distribution transformer). Dielectric tests in which the test voltages are low-frequency alternating voltages from an external source applied between conducting parts and ground without exciting the core of the transformer being tested. C57.12.80-1978

approach circuit. A circuit used to announce the approach of trains at block or interlocking stations. [119]

approach indicator. A device used to indicate the approach of a train. [119]

approach-light beacon (illuminating engineering). An aeronautical ground light placed on the extended centerline of the runway at a fixed distance from the runway threshold to provide an early indication of position during an approach to a runway. Note: The runway threshold is the beginning of the runway usable for landing. [127]

approach lighting. An arrangement of circuits so that the signal lights are automatically energized by the approach of a train. [119]

approach-lighting relay. A relay used to close the lighting circuit for signals upon the approach of a train. [119]

approach lights (illuminating engineering). A configuration of aeronautical ground lights located in extension of a runway or channel before the threshold to provide visual approach and landing guidance to pilots. [127]

approach locking (electric approach locking). Electric locking effective while a train is approaching, within a specified distance, a signal displaying an aspect to proceed, and that prevents, until after the expiration of a predetermined time interval after such signal has been caused to display its most restrictive aspect, the movement of any interlocked or electrically locked switch, movable-point frog, or deraill in the route governed by the signal, and that prevents an aspect to proceed from being displayed for any conflicting route. See: **interlocking**. [119]

approach navigation (navigation aid terms). Navigation during the time that the approach to a dock, runway, or other terminal facility is of immediate importance. 172-1983

approach path (navigation aid terms). That portion of the flight path between the point at which the descent for landing is normally started and the point at which the aircraft touches down on the runway. 172-1983

Exhibit 11

#1 SELLING Telecommunications Dictionary

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THE OFFICIAL GLOSSARY OF TELECOMMUNICATIONS AND COMPUTER ACRONYMS, TERMS AND JARGON

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NEWTON'S TELECOM DICTIONARY

APD Avalanche PhotoDiode. A diode that, when hit by light, increases its electrical conductivity by a multiplication effect. APDs are used in lightwave receivers because the APDs have great sensitivity to weakened light signals (i.e. those which have travelled long distances over fiber).

API Application Program Interface. A set of standard software interrupts, calls, and data formats that application programs use to initiate contact with network services, mainframe communications programs, or other program-to-program communications. For example, applications use APIs to call services that transport data across a network. Standardization of APIs at various layers of a communications protocol stack provides a uniform way to write applications. NetBIOS is an early example of a network application programming interface. Also, applications use APIs to call services that transport data across a network.

APL Automatic Program Load in telecom. In data processing, it's a popular programming language.

APLT See Advanced Private Line Termination.

APM Average Positions Manned, the average number of ACD positions manned during the reporting period for a particular group.

APOLOGIZE To lay the foundation for a future offense.

APPC 1. Advanced Peer-to-Peer Communications, also called Logical Unit 6.2, an IBM-specified network node definition featuring high-level program interaction capabilities on a peer-to-peer basis. 2. Advanced Program-to-Program Communications. An IBM protocol analogous to the OSI model's session layer: it sets up the necessary conditions that enable application programs to send data to each other through the network.

APPC/PC An IBM product that implements APPC on a PC.

APPEARANCE Usually refers to a private branch exchange line or extension which is on (i.e. "appears") on a multi-button key telephone. For example, extension 445 appears on three key systems.

APPEARANCE — TEST POINT The point at which a circuit may be measured by test equipment.

APPGEN A shortened form of the words APPLications GENerator.

APPLETALK Apple Computer's proprietary local area network for linking Macintosh computers and peripherals, especially LaserWriter printers. Appletalk is a CSMA/CD network that runs at 230.4 kilo bits per second and is therefore, incompatible with any other local area network. It is also a lot slower than the present top speeds of Ethernet (10 Mbps) and Token Ring (16 Mbps). Outside manufacturers, however, make gateways which will connect an Appletalk LAN to other local area and telecommunications networks — LANs, WANs and MANs. AppleTalk's LAN hardware is LocalTalk.

APPLICATION A software program that carries out some useful task. Database managers, spreadsheets, communications packages, graphics programs and word processors are all applications.

APP
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APP
form
inform
servic
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Exhibit 12


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Exhibit 13

Wikipedia



From Wikipedia, the free encyclopedia



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Wikipedia is a multilingual, Web-based, free-content encyclopedia project. The name is a portmanteau of the words *wiki* and *encyclopedia*. Wikipedia is written collaboratively by volunteers, allowing most of its articles to be edited by almost anyone with access to the Web site. Its main servers are in Tampa, Florida, with additional servers in Amsterdam and Seoul.

Wikipedia was launched as an English language project on January 15, 2001, as a complement to the expert-written and now defunct Nupedia, and is now operated by the non-profit Wikimedia Foundation. It was created by Larry Sanger and Jimmy Wales; Sanger resigned from both Nupedia and Wikipedia on March 1, 2002. Wales has described Wikipedia as "an effort to create and distribute a multi-lingual free encyclopedia of the highest possible quality to every single person on the planet in their own language".^[1]

Wikipedia has more than six million articles in many languages, including more than 1.5 million articles in the English-language version and more than half a million in the German-language version. There are 250 language editions of Wikipedia, and 18 of them have more than 50,000 articles. The German-language edition has been distributed on DVD-ROM, and there have been proposals for an English DVD or print edition. Since its inception, Wikipedia has steadily risen in popularity,^[2] and has spawned several sister projects. According to Alexa, Wikipedia ranks among the top fifteen most visited sites, and many of its pages have been mirrored or forked by other sites, such as Answers.com.

There has been controversy over Wikipedia's reliability and accuracy, with the site receiving criticism for its susceptibility to vandalism, uneven quality and inconsistency, systemic bias, and preference for consensus or popularity over credentials. Information is sometimes unconfirmed and questionable, lacking the proper sources that, in the eyes of most "Wikipedians" (as Wikipedia's contributors call themselves), are necessary for an article to be considered "high quality". However, a 2005 comparison (<http://www.nature.com/news/2005/051212/full/438900a.html>) performed by the science journal *Nature* of sections of Wikipedia and the *Encyclopædia Britannica* found that the two were close in terms of the accuracy of their articles on the natural sciences. This study was challenged by Encyclopædia Britannica, Inc., who described it as "fatally flawed".^[3]

W Wikipedia

	
URL	http://www.wikipedia.org/
Commercial?	No
Type of site	Internet encyclopedia project
Registration	Optional
Available language (s):	multi-lingual (171 active editions)
Owner	Wikimedia Foundation
Created by	Jimmy Wales and Larry Sanger

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Characteristics

Wikipedia uses a type of software called a "wiki", which allows for content to be authored by multiple people easily. Visitors are allowed to add, remove, or otherwise edit and change its content to help build the encyclopedia. Such contributions can be made without the need to register a user account.^[4] It is therefore possible for large numbers of people to write articles and update them quickly as new information becomes available; it also means online vandalism of and disagreement about content are common.

Many other Internet encyclopedia projects use traditional multi-lingual editorial policies and article ownership such as the expert-written *Stanford Encyclopedia of Philosophy*, Nupedia, h2g2 and Everything2. Projects such as Susning.nu, *Enciclopedia Libre*, and WikiZnanie are other wikis in which articles are developed by numerous authors, and there is no formal process of review. Unlike many encyclopedias, Wikipedia has licensed its content under the GNU Free Documentation License (GFDL).

Wikipedia has a set of policies identifying types of information appropriate for inclusion. These policies often are

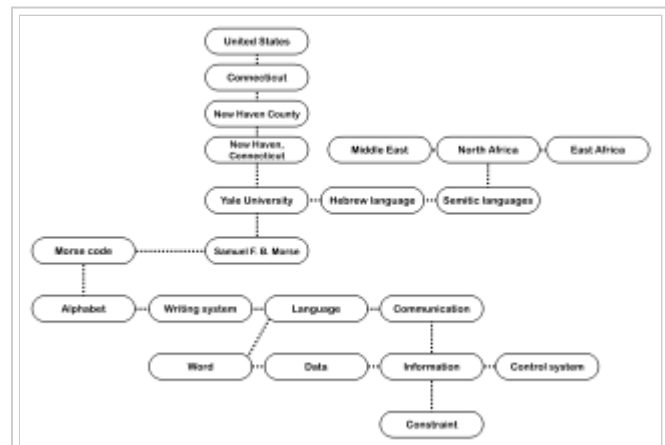


Image depicting the linking characteristics of a wiki; pages are linked together extensively, which allows the user to traverse a pathway of related articles

cited in disputes over whether particular content should be added, revised, transferred to a sister project, or removed. One of Wikipedia's core policies is that articles must be written from a "neutral point of view", presenting all noteworthy perspectives on an issue along with the evidence supporting them. The project also forbids the use of original research. Wikipedia articles do not attempt to determine an objective truth on their subjects, but rather to describe them impartially from all significant viewpoints. Following the introduction of a more user friendly citation functionality, since early 2006, articles increasingly include an extensive reference section to support the information presented in the article and to allow verification of the article.

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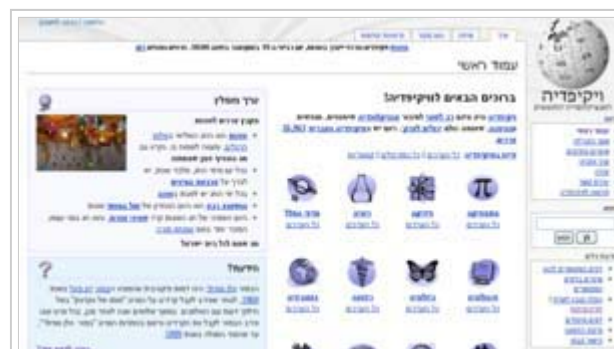
Language editions

Wikipedia encompasses 171 "active" language editions (ones with 100+ articles).^[7] In total, Wikipedia contains 250 language editions of varying states, with a combined 5 million articles.^[8]

Language editions operate independently from one another. Editions are not bound to the content of other language editions, nor are articles on the same subject required to be translations of each other. Automated translation of articles is explicitly disallowed, though multilingual editors of sufficient fluency are encouraged to manually translate articles. The various language editions are held to global policies such as "neutral point of view", though they may diverge on subtler points of policy and practice. Articles and images are shared between Wikipedia editions, the former through "InterWiki" links and pages to request translations, and the latter through the Wikimedia Commons repository. Translated articles represent only a small portion of articles in most editions.^[9]

According to Alexa Internet's audience measurement service, the English sub-domain (en.wikipedia.org)

receives approximately 60% of Wikipedia's cumulative traffic, with the remaining 40% being splintered between

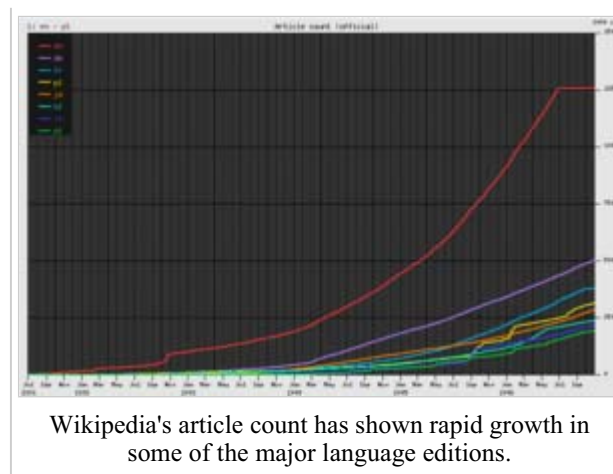


An example of Wikipedia's range in language editions:
Wikipedia in Hebrew.^[6]

the numerous other languages in which Wikipedia is offered.

The following is a list of the largest editions — those containing over 100,000 articles — sorted by number of articles as of December 24, 2006.^{[10][8]}

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3. French (412,112 (<http://fr.wikipedia.org/wiki/Special:Statistics?uselang=en>))
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10. Spanish (181,955 (<http://es.wikipedia.org/wiki/Special:Statistics?uselang=en>))
11. Russian (123,573 (<http://ru.wikipedia.org/wiki/Special:Statistics?uselang=en>))
12. Chinese (106,459 (<http://zh.wikipedia.org/wiki/Special:Statistics?uselang=en>))



Editing

Almost all visitors may edit Wikipedia's content; registered users can also create new articles. Changes made to pages are instantly displayed. Wikipedia is built on the expectation that collaboration among users will improve articles over time, in much the same way that open-source software develops. Some of Wikipedia's editors have explained its editing process as a "socially Darwinian evolutionary process".^[11] This real-time, collaborative model allows editors to rapidly update existing topics as they develop and to introduce new ones as they arise.

Some take advantage of Wikipedia's openness to add nonsense to the encyclopedia, which is called "vandalism". Additionally, collaboration sometimes leads to "edit wars" — multiple people repetitively replacing or removing each other's contributions because they disagree with each other — and prolonged disputes when editors are unable to agree on an article's content.^[12]

Editors keep track of changes to articles by checking the difference between two revisions of a page, displayed here in red.

Articles are always subject to editing, unless the article is protected for a short time owing to the aforementioned vandalism or revert wars. Wikipedia does not declare any of its articles to be "complete" or "finished". The authors of articles need not have any expertise or qualifications in the subjects that they edit, and users are warned



The "recent changes" page shows the newest edits to the English Wikipedia. This page is often watched by users who revert vandalism.

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Regular users often maintain a "watchlist" of articles of interest to them, so that they can easily keep tabs on all recent changes to those articles, including new updates, discussions, and vandalism. Most past edits to Wikipedia articles also remain viewable after the fact and are stored on "edit history" pages sorted chronologically, making it possible to see former versions of any page at any time. The only exceptions are the entire histories of articles that have been deleted, and many individual edits that contain libelous statements, copyright violations, and

other content that could incur legal liability or be otherwise detrimental to Wikipedia. These edits may only be viewed by Wikipedia administrators.

Wikipedia in other formats

For some articles, there is a spoken version available in ogg format (using the Vorbis audio codec). The ogg format is favored over the more ubiquitous and better-known MP3 format due to the decision to favor content accessible with "Free software" — MP3 fails this criteria as it is covered by multiple enforced software patents.^[14]

As Wikipedia is available online and released under an unrestrictive license, it is very easy to download its content for use on containers other than the Web, which is its primary distribution method. Accordingly, some projects have sprung up that use the Wikipedia content differently. For example, SOS Children distributes the encyclopedia on a CD (2006 Wikipedia CD Selection). Additionally, an editorial team is working on creating "Wikipedia 1.0", a collection of Wikipedia articles that have been verified for accuracy and are ready for printing or burning to CD. Published copies of selected Wikipedia articles are also available from PediaPress, a Print on Demand service.^[15] Stand-alone versions are available for handheld devices (for example, Lexipedia and Encyclopadia).

History



Wikipedia originally developed out of another encyclopedia project, Nupedia.

The Wikipedia concept was not novel — Everything2 (in 1998-1999) had used similar ideas before Wikipedia was founded — and Wikipedia began as a complementary project for Nupedia, a free online encyclopedia project whose articles were written by experts through a formal process. Nupedia was founded on March 9, 2000, under the ownership of Bomis, Inc, a Web portal company. Its principal figures were Jimmy Wales,

Bomis CEO, and Larry Sanger, editor-in-chief for Nupedia and later Wikipedia. Nupedia was described by Sanger as differing from existing encyclopedias in being open content, in not having size limitations, due to being on the Internet, and in being free of bias, due to its public nature and potentially broad base of contributors.^[16] Nupedia had a seven-step review process by appointed subject-area experts, but later came to be viewed as too

slow for producing a limited number of articles. Funded by Bomis, there were initial plans to recoup its investment by the use of advertisements.^[16] It was initially licensed under its own Nupedia Open Content License, switching to the GFDL before Wikipedia's founding at the urging of Richard Stallman.

On January 10, 2001, Larry Sanger proposed on the Nupedia mailing list to create a wiki alongside Nupedia. Under the subject "Let's make a wiki", he wrote:^[17]

“ No, this is not an indecent proposal. It's an idea to add a little feature to Nupedia. Jimmy Wales thinks that many people might find the idea objectionable, but I think not. (...) As to Nupedia's use of a wiki, this is the ULTIMATE "open" and simple format for developing content. We have occasionally bandied about ideas for simpler, more open projects to either replace or supplement Nupedia. It seems to me wikis can be implemented practically instantly, need very little maintenance, and in general are very low-risk. They're also a potentially great source for content. So there's little downside, as far as I can determine.



Jimmy Wales, Wikipedia co-founder and head of the Wikimedia Foundation

Wikipedia was formally launched on January 15, 2001, as a single English-language edition at <http://www.wikipedia.com/>, and announced by Sanger on the Nupedia mailing list.^[18] It had been, from January 10, a feature of Nupedia.com in which the public could write articles that could be incorporated into Nupedia after review. It was relaunched off-site after Nupedia's Advisory Board of subject experts disapproved of its production model.^[19] Wikipedia thereafter operated as a standalone project without control from Nupedia. Its policy of "neutral point-of-view" was codified in its initial months, though it is similar to Nupedia's earlier "nonbiased" policy. There were otherwise few rules initially. Wikipedia gained early contributors from Nupedia, Slashdot postings, and search engine indexing. It grew to approximately 20,000 articles, and 18 language editions, by the end of its first year. It had 26 language editions by the end of 2002, 46 by the end of 2003, and 161 by the end of 2004.^[20] Nupedia and Wikipedia coexisted until the former's servers went down, permanently, in 2003, and its text was incorporated into Wikipedia.

Wales and Sanger attribute the concept of using a wiki to Ward Cunningham's WikiWikiWeb or Portland Pattern Repository. Wales mentioned that he heard the concept first from Jeremy Rosenfeld, an employee of Bomis who showed him the same wiki, in December 2000,^[21] but it was after Sanger heard of its existence in January 2001 from Ben Kovitz, a regular at the wiki,^[19] that he proposed the creation of a wiki for Nupedia to Wales and Wikipedia's history started. Under a similar concept of free content, though not wiki-based production, the GNUpedia project existed alongside Nupedia early in its history. It subsequently became inactive, and its creator, free-software figure Richard Stallman, lent his support to Wikipedia.^[22]

Citing fears of commercial advertising and lack of control in a perceived English-centric Wikipedia, users of the Spanish Wikipedia forked from Wikipedia to create the *Enciclopedia Libre* in February 2002. Later that



Wikipedia's English edition on March 30, 2001, two and a half months after its founding.

year, Wales announced that Wikipedia would not display advertisements, and its website was moved to wikipedia.org. Various other projects have since forked from Wikipedia for editorial reasons, such as Wikinfo, which abandoned "neutral point-of-view" in favor of multiple complementary articles written from a "sympathetic point-of-view".^[23]

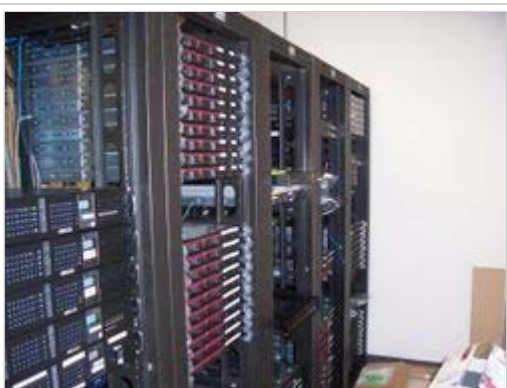
Wikipedia's first sister project, "In Memoriam: September 11 Wiki", was created in October 2002 to detail the September 11, 2001 attacks;^[24] The Wikimedia Foundation was created from Wikipedia and Nupedia on June 20, 2003.^[25] Wikipedia and its sister projects thereafter operated under this non-profit organization. Wiktionary, a dictionary project, was launched in December 2002; Wikiquote, a collection of quotations, a week after Wikimedia launched; and Wikibooks, a collection of collaboratively-written free books, the next month. Wikimedia has since started a number of other projects, detailed below.

Wikipedia has traditionally measured its status by article count. In its first two years, it grew at a few hundred or fewer new articles per day; by 2004, this had accelerated to a total of 1,000 to 3,000 per day (counting all editions). The English Wikipedia reached its 100,000-article milestone on January 22, 2003.^[26] Wikipedia reached its one millionth article, among the 105 language editions that existed at the time, on September 20, 2004,^[27] while the English edition alone reached its 500,000th on March 18, 2005.^[28] This figure had doubled less than a year later, with the millionth article in the English edition, Jordanhill railway station (http://en.wikipedia.org/wiki/Jordanhill_railway_station), being created on March 1, 2006^[29]; meanwhile, the millionth user registration had been made just two days before. The 1.5 millionth article was created on November 25, 2006 about the Kanab Ambersnail.^[30]

The Wikimedia Foundation applied to the United States Patent and Trademark Office to trademark *Wikipedia®* on September 17, 2004. The mark was granted registration status on January 10, 2006. Trademark protection was accorded by Japan on December 16, 2004 and in the European Union on January 20, 2005. Technically a service mark, the scope of the mark is for: "Provision of information in the field of general encyclopedic knowledge via the Internet".

There are plans to license the usage of the Wikipedia trademark for some products, such as books or DVDs.^[31]

Software and hardware



Wikipedia receives over 2000 page requests per second. More than 100 servers have been set up to handle the traffic.

Wikipedia itself runs on its own in-house created software, known as MediaWiki, a powerful, open source wiki system written in PHP and built upon MySQL.^[32] As well as allowing articles to be written, it includes a basic internal macro language, variables and transcluded templating system for page enhancement, and features such as redirection.

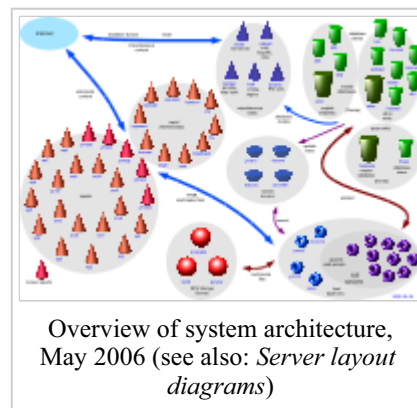
Wikipedia runs on a cluster of dedicated Linux servers located in Florida and four other locations around the world.^[33] MediaWiki is Phase III of the program's software. Originally, Wikipedia ran on UseModWiki by Clifford Adams (Phase I). At first it required camel case for links; later it was also possible to use double brackets. Wikipedia began running on a PHP wiki engine with a MySQL database in January 2002. This software, Phase II, was written specifically for the Wikipedia project by Magnus Manske. Several rounds of modifications were made to

improve performance in response to increased demand. Ultimately, the software was rewritten again, this time by Lee Daniel Crocker. Instituted in July 2002, this Phase III software was called MediaWiki. It was licensed under

the GNU General Public License and used by all Wikimedia projects.

Wikipedia was served from a single server until 2004, when the server setup was expanded into a distributed multitier architecture. In January 2005, the project ran on 39 dedicated servers located in Florida. This configuration included a single master database server running MySQL, multiple slave database servers, 21 web servers running the Apache software, and seven Squid cache servers. By September 2005, its server cluster had grown to around 100 servers in four locations around the world.

Page requests are processed by first passing to a front-end layer of Squid caching servers. Requests that cannot be served from the Squid cache are sent to two load-balancing servers running the Perlbal software, which then pass the request to one of the Apache web servers for page-rendering from the database. The web servers serve pages as requested, performing page rendering for all the Wikipedias. To increase speed further, rendered pages for anonymous users are cached in a filesystem until invalidated, allowing page rendering to be skipped entirely for most common page accesses, which can lead to a lag. To further increase response times, Wikimedia began building a global network of caching servers with the addition of three caching servers in France. Two larger clusters in the Netherlands and Korea now take much of Wikipedia's traffic load. In spite of all this, Wikipedia page load times remain quite variable. The ongoing status of Wikipedia's website is posted by users at a status page (http://openfacts.berlios.de/index-en.phtml?title=Wikipedia_Status) on OpenFacts.



Authorship and management process

During December 2005, Wikipedia had about 27,000 users who made at least five edits that month; 17,000 of these active users worked on the English edition.^[34] A more active group of about 4,000 users made more than 100 edits per month, over half of these users having worked in the English edition. According to Wikimedia, one-quarter of Wikipedia's traffic comes from users without accounts, who are less likely to be editors.^[35]

Maintenance tasks are performed by a group of volunteer developers, stewards, bureaucrats, and administrators, which number just over a thousand. Administrators are the largest such group, privileged with the ability to prevent articles from being edited, delete articles, or block users from editing in accordance with community policy. Any editor with a significant history of positive contributions and a firm understanding of Wikipedia's policies and guidelines can be nominated to become an administrator.

Some users have been temporarily or permanently blocked from editing Wikipedia. Vandalism or the minor infraction of policies may result in a warning or temporary block, while long-term or permanent blocks for prolonged and serious infractions are given by Jimmy Wales or, on its English edition, an elected Arbitration Committee.

Former Nupedia editor-in-chief Larry Sanger has said that having the GFDL license as a "guarantee of freedom is a strong motivation to work on a free encyclopedia".^[36] In a study of Wikipedia as a community, economics professor Andrea Ciffolilli argued that the low transaction costs of participating in wiki software create a catalyst for collaborative development, and that a "creative construction" approach encourages participation.^[37] Wikipedia has been viewed as an experiment in a variety of social, political, and economic systems, including anarchy, democracy, and communism. Its founder has replied that it is not intended as one, though that is a consequence.^[38] Daniel Brandt of Wikipedia Watch has referred to Jimbo Wales as the "dictator" of Wikipedia; however, most Wikipedia users either do not consider Wales to be a dictator, or consider him to be one who rarely

gives non-negotiable orders.^[39]

Future directions for authoring content

An experimental feature planned for the German version of Wikipedia has been reported which could eventually improve the quality of editing for Wikipedia and protect it from vandalism. The concept being tested is to still allow anyone to edit articles, but to only allow editors judged as "trustworthy" to make edits live on the public site. The process by which trustworthiness would be established is yet to be determined. Jimbo Wales stated "We want to let anybody edit but we don't want to show vandalized versions. It would be fun for me to announce to the press that the front page of Wikipedia is open for public editing for the first time in five years".^[40]

Funding

Wikipedia is funded through the Wikimedia Foundation. Its 4th Quarter 2005 costs were \$321,000 USD, with hardware making up almost 60% of the budget.^[41]

Bomis, an online advertising company that caters to a generally male audience and has hosted soft-core pornography, played a significant part in the early development of Wikipedia and the network itself.^[42] Wikipedia holds regular fundraisers asking the community for donations.^[43]

Criticism and controversy

Further information: Criticism of Wikipedia

Wikipedia has become increasingly controversial as it has gained prominence and popularity, with critics alleging that Wikipedia's open nature makes it unauthoritative and unreliable, with unconfirmed information that often lacks any proper sources, and that it exhibits severe systemic bias and inconsistency. Wikipedia has also been criticized for using dubious sources, having a biased but neutrally written perspective towards certain points of view, for disregarding credentials, for lacking understanding and international nature, and for being vulnerable to vandalism and special interest groups.^[44] Critics of Wikipedia include Wikipedia's own editors (and ex-editors), representatives of other encyclopedias, and even subjects of articles, especially those that find information presenting them in a bad light.

At the end of 2005, controversy arose after journalist John Seigenthaler, Sr. found that his biography had been written largely as a hoax, which had gone undetected for 132 days. ^[45] This discovery led to several policy decisions within Wikimedia regarding creation of articles and the overview process, intended to address some of the flaws which had allowed the hoax to go undetected for that time.

The Wikipedia model

Wikipedia has been both praised and criticized for being open to editing by anyone. Critics allege that non-expert editing undermines quality. Because contributors usually submit *edits*, rewriting small portions of an entry rather than making full-length revisions, high- and low-quality content may be intermingled within an entry.

Wikipedia has been criticized for a perceived lack of reliability, comprehensiveness and authority. It is criticized as having no or limited utility as a reference work among many librarians, academics, and the editors of more formally written encyclopedias. Many university lecturers discourage their students from using any encyclopedia as a reference in academic work, preferring primary sources instead.^[46] A critical website, Wikipedia Watch, was created by Daniel Brandt, accusing Wikipedia of having "...a massive, unearned influence on what passes for

reliable information."^[47]

Supporters argue that Wikipedia does meet all the criteria for the basic definition of the word 'encyclopedia'. One difference from book encyclopedias is online web editing with Wikipedia's history function. A deleted text will remain in the history tab and other users can look up an individual's work history to gauge the author's merit.

Emigh and Herring (2005)^[48] in a study of Wikipedia, note that there are not yet many formal studies of Wikipedia or its model. Their main conclusions regarding style and encyclopedic quality were:

1. Statistically speaking, "the language of Wikipedia entries is as formal as that in the traditional print encyclopedia".
2. Wikipedia entries are "stylistically homogenous, typically describe only a single, core sense of an item, and are often presented in a standard format" (attributed partly to policies and partly to the norms of conventional print encyclopedias "which Wikipedia effectively emulates").
3. Wikipedia achieves its results by social means, including self-norming, a core of active and vigilant users watching for problems, and editors' expectations of encyclopedic text drawn from the wider culture.

Reliability

Wikipedia can be assessed for reliability in several areas, including:

- Accuracy of information provided within articles;
- Comprehensiveness, scope and coverage within articles and in the range of articles;
- Susceptibility to, and exclusion and removal of, false information (a criterion specific to the Wikipedia process);
- Susceptibility to editorial and systemic bias;
- Identification of reputable third party source references (citations).

Accuracy and comprehensiveness

A variety of studies to date have tended to suggest that some Wikipedia articles (scientific articles most notably) are of a similar degree of accuracy to *Encyclopædia Britannica*, that Wikipedia provides a good starting point for research, and that articles are, in general, reasonably sound. However, these studies also suggest that due to its novel editorial model, it suffers omissions and inaccuracies which can sometimes be serious. A separate study suggests that in many cases, vandalism is reverted fairly quickly, but that this does not always happen.

One of the studies, by *Nature*, identified that among 42 entries tested, the difference in accuracy was relatively low: the average science entry in Wikipedia contained around four inaccuracies; Britannica, around three. In the pairs of articles reviewed, eight serious errors such as misinterpretations of important concepts were detected, four from each encyclopædia. Reviewers also found many factual errors, omissions or misleading statements: 162 in Wikipedia and 123 in Britannica. However, the study did find that the errors on Wikipedia were generally more severe, with a greater proportion of factual errors, while the errors in Britannica were more commonly errors of omission. However, it was also found that Wikipedia articles were generally of greater length (2.6 times as long as the Britannica equivalents, on average), and that thus its error per word ratio is lower.^[49]

Critics of Wikipedia often charge that allowing anyone to edit makes Wikipedia an unreliable work, and that some editors may employ clever use of semantics to make possibly biased statements sound more credible. Wikipedia contains no formal peer review process for fact-checking, and the editors themselves may not be well-versed in the topics they write about, leading to criticism that its contents lack authority,^[50] and according to Danah Boyd, that "[i]t will never be an encyclopedia, but it will contain extensive knowledge that is quite valuable for different purposes."^[51]

Although Wikipedia has a policy of citing reputable sources, this is only sometimes adhered to. *Encyclopædia Britannica*'s executive editor, Ted Pappas, was quoted in *The Guardian* as saying: "The premise of Wikipedia is that continuous improvement will lead to perfection. That premise is completely unproven."^[50] and former *Britannica* editor Robert McHenry criticized the wiki approach on the grounds that "What [a user] certainly does not know is who has used the facilities before him".^[52]

Academic circles have not been exclusively dismissive of Wikipedia as a reference. Wikipedia articles have been referenced in "enhanced perspectives" provided on-line in *Science*. The first of these perspectives to provide a hyperlink to Wikipedia was "A White Collar Protein Senses Blue Light",^[53] and dozens of enhanced perspectives have provided such links since then. However, these links are offered as background sources for the reader, not as sources used by the writer, and the "enhanced perspectives" are not intended to serve as reference material themselves.

Former Nupedia editor-in-chief Larry Sanger criticized Wikipedia in late 2004 for having, according to Sanger, an "anti-elitist" philosophy of active contempt for expertise.^[54] It is possible that articles subject to strong opinions (such as George W. Bush) are more prone to be edited poorly, but this is uncertain — often such articles receive extra attention and strong consensus exactly because they are the subject of heated debate. Other articles that do not produce such emotive responses may tend to be more stable.

Other commentators have drawn a middle ground, that it contains much valuable knowledge and has some reliability, even if the degree is not yet assessed with certainty. People taking such a view include Danah Boyd, Larry Sanger (re-applying Eric Raymond's "Given enough eyeballs, all errors are shallow"^[55]) and technology figure Joi Ito, who wrote, "the question is whether something is more likely to be true coming from a source whose resume sounds authoritative or a source that has been viewed by hundreds of thousands of people (with the ability to comment) and has survived."^[56]

Bill Thompson, a well known technology writer, commented that the debate is probably symptomatic of much learning about information which is happening in society today, arguing that:

“ It is the same with search engine results. Just because something comes up in the top 10 on MSN Search or Google does not automatically give it credibility or vouch for its accuracy or importance... One benefit that might come from the wider publicity that Wikipedia is receiving is a better sense of how to evaluate information sources... The days when everything you saw on a screen had been carefully filtered, vetted, edited and checked are long gone. Product placement, advertorials and sponsorship are all becoming more common. An educated audience is the only realistic way to ensure that we are not duped, tricked, fleeced or offended by the media we consume, and learning that online information sources may not be as accurate as they pretend to be is an important part of that education. I use the Wikipedia a lot. It is a good starting point for serious research, but I would never accept something that I read there without checking. ”

—Bill Thompson, What is it with Wikipedia? (<http://news.bbc.co.uk/1/hi/technology/4534712.stm>)

Coverage

A common criticism is that editors, being volunteers, write on what interests them, and what they are aware of. Therefore, coverage is uneven and may at times be seriously unbalanced, with notable omissions.

Wikipedia has been accused of deficiencies in comprehensiveness because of its voluntary nature, and of reflecting the systemic biases of its contributors. For example, like any Internet group, the site can become dominated by cliques of habitual users who express condescension and hostility to users not involved in the "in-

group" — habitual users also feel a sense of "ownership" over "their" pages, leading to edit wars.

Encyclopædia Britannica's editor-in-chief Dale Hoiberg has argued this case,^[50] as has former Nupedia editor-in-chief Larry Sanger who stated in 2004 that "when it comes to relatively specialized topics (outside of the interests of most of the contributors), the project's credibility is very uneven."^[54]

The same fluidity that allows articles to be patchy has also led to Wikipedia being praised for making it possible for articles to be updated or created in response to current events. For example, the then-new article on the 2004 Indian Ocean earthquake on its English edition was cited often by the press shortly after the incident.^[57] Its editors have also argued that, as a website, Wikipedia is able to include articles on a greater number of subjects than print encyclopedias may.^[58]

Bias

Wikipedia has been criticized as having a systematic bias in three ways. First, there could be an unintentional bias due to the overall makeup of the community of Wikipedia editors. For instance, because Wikipedia's basic model is popular and nonmonetary, this could lead to a shortage of editors with elitist or strongly pro-capitalist views. There is no doubt that Wikipedia includes a wide diversity of editors, and important articles which are the focus of a controversy generally receive input from editors on both sides of this controversy; but this weak bias would tend to show up in more secondary articles. Second, there could be an intentional bias within a given article due to the focused efforts of a single editor or a small group of editors. This would also tend to be confined to secondary articles which receive less editorial attention. In general, this bias would be more or less strong, and thus possibly detectable by a critical reader. Third, there could be a bias introduced by some other aspect of Wikipedia. The tendency to use web-based sources, the policies against original research, and the injunction to maintain a "neutral point of view" could all be sources of bias, especially if overapplied.

Objective, or neutrally biased, articles present different opinions as equally legitimate regardless of validity, while unbiased articles focus on accuracy and validity. For example, the evolution article is not objective because it does not present creationism, a counter argument to evolution, as a valid scientific theory. However, this does not make the article biased because evolution is an accepted scientific theory.

CNN's Crossfire, on the other hand, was considered objective because it had representatives from the political right from the political left.

Community

The Wikipedia community (http://meta.wikimedia.org/wiki/The_Wikipedia_Community) consists of users who are proportionally few, but highly active. Emigh and Herring argue^[48] that "a few active users, when acting in concert with established norms within an open editing system, can achieve ultimate control over the content produced within the system, literally erasing diversity, controversy, and inconsistency, and homogenizing contributors' voices."^[48] Editors on Wikinfo, a fork of Wikipedia, similarly argue that new or controversial editors to Wikipedia are often unjustly labeled "trolls" or "problem users" and blocked from editing.^[59] Its community has also been criticized for responding to complaints regarding an article's quality by advising the complainer to fix the article (a common complaint about open-source software development as well).^[60] It has also been described as "cult-like",^{[61][62][63][64]} although, as these instances demonstrate, not always with entirely negative connotations.

In a page on researching with Wikipedia, the community view is argued that Wikipedia is valuable for being a social community, in that authors can be asked to defend or clarify their work, and disputes are readily seen.^[65] Wikipedia editions also often contain reference desks in which the community answers questions.

Professor James H. Fetzer criticized Wikipedia in that he could not change the article about himself; Wikipedia has a policy that prohibits the editing of biographies by the subjects themselves.^[66]

This problem has caused a lack of intellectual freedom. The freedom of Wikipedia, for example, is more virtual than anything. The ability of anyone to actually create reasoning or opinions of their own is very limited on Wikipedia. The Enlightenment tradition of "Sapere aude!" does not apply to Wikipedia. Wikipedia can be in some ways the ultimate in neutral censorship. As Fahrenheit 451, by Ray Bradbury, says, "[d]on't step on the toes of the dog lovers, the cat lovers, doctors, lawyers, merchants, chiefs, Mormons, Baptists, Unitarians, second-generation Chinese, Swedes, Italians, Germans, Texans, Brooklynites, Irishmen, people from Oregon or Mexico." In short, true freedom is lost, or is in the process of being lost, to political correctness. Where are the ideals that have led to intellectual development? How can we realize, for example, Martin Luther's view of every individual being a priest, when those without recognition are cast out from developing their own ideas!?

The pages Wikipedia:Articles_for_deletion and Wikipedia:deletion_policy highlight the extent of this seeming intolerance. Situations including lack of notability and sources, as well as a lack of neutrality, can contribute to the deletion or heavy editing of an article. Where in the cases of persons or establishment, the notability rules prevent advertising, the deletion policy on biased articles can prevent the actual development of ideas or debate, and lead to the destruction of a concept merely because it was not presented in the most neutral fashion. Additionally, articles, especially when they concern the traits of ethnic or gender groups, have been edited or considered for deletion due to content that is not politically correct, even if it is true and supported by empirical data. Examples include race_and_intelligence and gender_and_intelligence. Articles such as this one, which could cause some to revise their ideas about a subject, are often considered for deletion merely because they are not yet well known.

Responses to criticisms

In an interview (http://www.businessweek.com/technology/content/dec2005/tc20051214_441708.htm) with *BusinessWeek* on December 13, 2005, Wales discussed the reasons that the Seigenthaler hoax had gone undetected, and steps being taken to address them. He stated that one problem was that Wikipedia's use had grown faster than its self-monitoring system could comfortably handle, and that therefore new page creation would be deliberately restricted to account-holders only, addressing one of Seigenthaler's main criticisms. He also gave his opinion that encyclopedias as a whole (whether print or online) were not usually appropriate for primary sources and should not be relied upon as authoritative (as some were doing), but that nonetheless on balance Wikipedia was more reliable as "background reading" on subjects than most online sources. He stated that Wikipedia was a "work in progress".^[67]

In response to this criticism, proposals have been made to provide various forms of provenance for material in Wikipedia articles.^[68] The idea is to provide *source provenance* on each interval of text in an article and *temporal provenance* as to its vintage. In this way a reader can know "who has used the facilities before him" and how long the community has had to process the information in an article to provide calibration on the "sense of security". For example, Cross^[69] proposes a temporal provenance scheme which colors text based how many edit sessions a piece of text has survived (red for new text, yellow for text that has survived 50 edits, green if 100, black if more than 150 edits). However, these proposals for provenance are quite controversial. Aaron Krowne wrote a rebuttal article in which he criticized McHenry's methods, and labeled them "FUD", the marketing technique of "fear, uncertainty, and doubt".^[70]

Awards

Wikipedia won two major awards in May 2004.^[71] The first was a Golden Nica for Digital Communities,

awarded by Prix Ars Electronica; this came with a €10,000 (\$12,700) grant and an invitation to present at the PAE Cyberarts Festival in Austria later that year. The second was a Judges' Webby award for the "community" category.^[72] Wikipedia was also nominated for a "Best Practices" Webby. In September 2004, the Japanese Wikipedia was awarded a Web Creation Award from the Japan Advertisers Association. This award, normally given to individuals for great contributions to the Web in Japanese, was accepted by a long-standing contributor on behalf of the project.

Wikipedia has also received plaudits from sources including the *BBC News*, *The Washington Post*, *The Economist*, *Newsweek*, *Los Angeles Times*, *Science*, *The Guardian*, *Chicago Sun-Times*, *The Times* (London), *Toronto Star*, *Globe and Mail*, *The Financial Times*, *Time Magazine*, *Irish Times*, *Reader's Digest*, and *The Daily Telegraph*. Founder Jimmy Wales was named one of the 100 most influential people in the world by *TIME Magazine* in 2006.^[73]

In a 2006 *Multiscope* research study, the Dutch Wikipedia was rated the third best Dutch language site (after Google and Gmail), with a score of 8.1.^[74]

In popular culture

Wikipedia's content has been mirrored and forked by hundreds of sites including database dumps. Wikipedia content has also been used in academic studies, books and conferences, albeit more rarely, and very recently, in movies. As of 2006, Wikipedia has been used once in a United States court case,^[75] and the Parliament of Canada website refers to Wikipedia's article on same-sex marriage in the "further reading" list of Civil Marriage Act.^[76] Some Wikipedia users, or *Wikipedians*, maintain (non-comprehensive) lists of such uses.^[77]

With increased usage and awareness, there have been an increasing number of references to Wikipedia in popular culture. Many parody Wikipedia's openness, with characters vandalizing or modifying the online encyclopedia project's articles. Stephen Colbert of the Colbert Report has often times instigated his viewers to vandalize articles in humorous ways, once doing so on the Wikipedia article on elephants. "Weird Al" Yankovic's character in his video 'White & Nerdy' is seen vandalising the entry for the Atlantic record label with the exclamation "You suck!", after they rescinded permission for a parody.

In the American version of Shin Megami Tensei: Digital Devil Saga, Wikipedia is a selectable mantra.

See also

- Congressional staffer edits to Wikipedia
- Encyclopedia
- Internet encyclopedia project
- List of encyclopedias
- List of wikis
- Open Site
- Self-reference
- User-generated content
- Wikipedia in popular culture

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4. ^ Registering an account grants the user some additional privileges, such as creating and renaming ("moving") articles.
5. ^ Note that it is the United States copyright law that applies to all of Wikipedia's content.
6. ^ <http://he.wikipedia.org/wiki/>
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8. ^ *a b* "Complete list of language Wikipedias available (http://meta.wikimedia.org/wiki/Complete_list_of_language_Wikipedias_available)", Meta-Wiki, April 15, 2006
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- Wikipedia:Introduction
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- Wikipedia:Wikipedia in academic studies
- Wikipedia:Press releases
- Wikipedia:Press coverage
- Wikipedia:Why Wikipedia is not so great
- Wikipedia:Replies to common objections
- Wikipedia:Improving Wikipedia
- Wikipedia:Statistics

External links

Links to content created under a Wikimedia Foundation project

- wikipedia.org (<http://www.wikipedia.org/>), multi-lingual portal
 - en.wikipedia.org (<http://en.wikipedia.org/>), English language edition
- Meta-Wiki (<http://meta.wikipedia.org/>), policy-related and technical discussions regarding Wikimedia
- Wikimedia Foundation (<http://www.wikimediafoundation.org/>), parent organization of Wikipedia
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- WiKP (<http://www.wikp.com/>): WiKP, a Google-based Wikipedia search engine

Retrieved from "<http://en.wikipedia.org/wiki/Wikipedia>"

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Exhibit 14

IEEE Std 100-1992

**The New IEEE Standard Dictionary
of Electrical and Electronics Terms**
[Including Abstracts of All Current IEEE Standards]

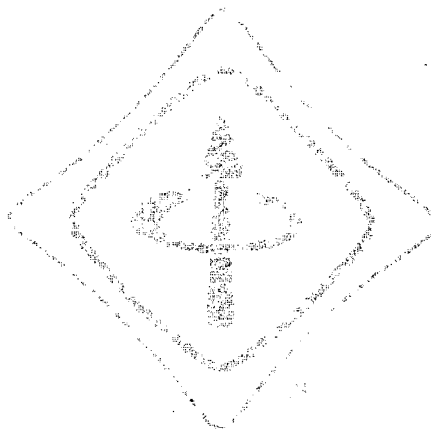
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January 15, 1993

SH15594

priority

1008

privileged instruction

recording medium to another section of the same medium when these sections are brought into proximity. *Note:* The resulting copy usually is distorted. [32]

priority (1) (computer graphics). A segment attribute that determines which of several overlapping segments is closer to the viewer. 610.6-1991

(2) (software). The level of importance assigned to an item. 610.12-1990

(3) (multiprocessor architectures). A bus request protocol in which the module with the highest arbitration number acquires the bus. 896.1-1987

(4) (use in primitives). A parameter used to convey the priority required or desired. 8802.2-1989

priority interrupt. An interrupt performed to permit execution of a process that has a higher priority than the process currently executing. 610.12-1990

priority interrupt bus. One of the four buses provided by the backplane. The priority interrupt bus allows interrupter modules to send interrupt requests to interrupt-handler modules. 1014-1987

priority queue. A list to which items may be appended to or retrieved from any position, depending on some property of the item being added or removed. *Note:* This data structure is misnamed in that it contradicts the definition of queue. 610.5-1990

priority string (power-system communication). A series connection of logic circuits such that inputs are accommodated in accordance with their position in the string, one end of the string corresponding to the highest priority. *See:* digital. [123]

privacy system (radio transmission). A system designed to make unauthorized reception difficult. *See:* radio transmission. [119]

private. A design feature intended solely for use by the component manufacturer. 1149.1-1990

private automatic branch exchange (PABX) (telephone switching systems) (data transmission). A private branch exchange that is automatic. 312-1977w, 599-1985w

private automatic exchange (PAX) (telephone switching systems) (data transmission). A private nonbranch exchange that is automatic. 312-1977w, 599-1985w

private branch exchange (PBX) (telephone switching systems) (data transmission). A private telecommunications exchange that includes access to a public telecommunications exchange. 312-1977w, 599-1985w

private branch exchange hunting (telephone switching systems). An arrangement for searching over a group of trunks at the central office, any one of which would provide a

connection to the desired private branch exchange. 312-1977w

private-branch-exchange trunk (PBX) (telephone switching systems). A line used as a trunk between a private branch exchange and the central office that serves it. 312-1977w

private exchange. A telephone exchange serving a single organization and having no means for connection with a public telephone exchange. [28], [48]

private line (private wire) (data transmission). A channel or circuit furnished to a subscriber for the subscriber's exclusive use. 599-1985w

private line telegraph network (data transmission). A system of points interconnected by leased telegraph channels and providing hard-copy or five-track punched paper tape, or both, at both sending and receiving points. 599-1985w

private line telephone network (data transmission). A series of points interconnected by leased voice-grade telephone lines, with switching facilities or exchange operated by the customer. 599-1985w

private non-branch exchange (telephone switching systems). A series of points interconnected by leased voice-grade telephone lines, with switching facilities or exchange operated by the customer. [123]

private residence. A separate dwelling or a separate apartment in a multiple dwelling that is occupied only by the members of a single family unit. [119]

private residence elevator. A power passenger electric elevator, installed in a private residence, and that has a rated load not in excess of 700 pounds, a rated speed not in excess of 50 feet per minute, a net inside platform area not in excess of 12 square feet, and a rise not in excess of 50 feet. *See:* elevators. [119]

private-residence inclined lift. A power passenger lift, installed on a stairway in a private residence, for raising and lowering persons from one floor to another. *See:* elevator. [119]

private telecommunication exchange (telephone switching systems). A telecommunications exchange for a single organization. 312-1977w

private telephone network. A telephone network set up solely to meet the requirements of the particular organization. 823-1989

private type. A data type whose structure and possible values are defined but are not revealed to the user of the type. *See also:* information hiding. 610.12-1990

privileged instruction (software). A computer instruction that can be executed only by a supervisory program. 610.12-1990

Exhibit 15

#1 SELLING
Telecommunications
Dictionary

FOURTH EDITION

22nd, 10th, 10th, 10th

OPEN A NEW WORLD
FOR YOUR BUSINESS

DOES NOT CIRCULATE

DO NOT REMOVE FROM
BOSTON LIBRARY

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TELECOM
dictionary

THE OFFICIAL GLOSSARY OF TELECOMMUNICATIONS AND
COMPUTER ACRONYMS, TERMS AND JARGON

by Harry Newton

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SONET: Planning, Installing & Maintaining Broadband Networks

The TELECONNECT Guide to

Automatic Call Distributors

The Business of Interconnect

How to Sell Call Accounting Systems

Professional Selling

and...

101 Money-Saving Secrets Your Phone Company Won't Tell You

Frames, Packets and Cells in Broadband Networking

Profit and Control Through Call Accounting

Telecommunications Management for Business and Government

The Dictionary of Sales and Marketing Technology Terms

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NEWTON'S TELECOM DICTIONARY

PRIORITIZATION The process of assigning different values to network users, such that a user with higher priority will be offered access or service before a user with lower priority. Increasingly available as an added option with network operation. Any procedure where different levels of precedence exist.

PRIORITY A ranking given to a task which determines when it will be processed.

PRIORITY BUMPING The process during a link, trunk or facility failure where lower priority user access to network services is interrupted in order to offer those services or bandwidth to a predesignated higher priority user.

PRIORITY CALL Emergency calls to the attendant bypass the normal queue and alert the attendant with some special signal.

PRIORITY INDICATOR A character or group of characters which determine the position in queue of the message in relation to the urgency of other messages. Priority indicators control the order in which messages are to be delivered.

PRIORITY RINGING A name for a Pacific Bell (and possibly other local telephone companies') service which alerts you to have calls from selected numbers ring at another number.

PRIORITY TRANSPORT The capability of a network for certain classes of traffic to have priority over others and thus have lower delay or otherwise better performance.

PRIORITY TRUNK QUEUING Through user-chosen trunk access level, this PBX feature places any caller with this or higher level in the class of service assignment ahead of callers waiting for the same trunk group (or Agent Group in the case of incoming ACD calls).

PRIVATE AUTOMATIC BRANCH EXCHANGE See PABX.

PRIVATE BRANCH EXCHANGE See PBX.

PRIVATE NETWORKS MARKETING A Northern Telecom term which defines their organization for making and selling all telecom switches, except central offices. These products include the Meridian 1 PBX family, residential and business telephone sets, including Norstar and data communications.

PRIVACY Privacy usually means that once a caller "seizes" a line, no other user can access that same line even though it appears on his/her key set. Privacy can be automatic or selected for each call.

PRIVACY AND PRIVACY RELEASE All other extensions of a line are unable to enter a conversation in progress unless the initiating telephone releases the feature.

PRIVACY LOCKOUT Privacy automatically splits the connection whenever an attendant would otherwise be included on the call, i.e. the attendant can't listen in to a call she's just extended to someone. A tone warning is generated when the attendant bridges into a conversation in progress.

Exhibit 16

OSI Reference Model—The ISO Model of Architecture for Open Systems Interconnection

HUBERT ZIMMERMANN

(Invited Paper)

Abstract—Considering the urgency of the need for standards which would allow constitution of heterogeneous computer networks, ISO created a new subcommittee for "Open Systems Interconnection" (ISO/TC97/SC16) in 1977. The first priority of subcommittee 16 was to develop an architecture for open systems interconnection which could serve as a framework for the definition of standard protocols. As a result of 18 months of studies and discussions, SC16 adopted a layered architecture comprising seven layers (Physical, Data Link, Network, Transport, Session, Presentation, and Application). In July 1979 the specifications of this architecture, established by SC16, were passed under the name of "OSI Reference Model" to Technical Committee 97 "Data Processing" along with recommendations to start officially, on this basis, a set of protocols standardization projects to cover the most urgent needs. These recommendations were adopted by TC97 at the end of 1979 as the basis for the following development of standards for Open Systems Interconnection within ISO. The OSI Reference Model was also recognized by CCITT Rapporteur's Group on "Layered Model for Public Data Network Services."

This paper presents the model of architecture for Open Systems Interconnection developed by SC16. Some indications are also given on the initial set of protocols which will likely be developed in this OSI Reference Model.

I. INTRODUCTION

IN 1977, the International Organization for Standardization (ISO) recognized the special and urgent need for standards for heterogeneous informatic networks and decided to create a new subcommittee (SC16) for "Open Systems Interconnection."

The initial development of computer networks had been fostered by experimental networks such as ARPANET [1] or CYCLADES [2], immediately followed by computer manufacturers [3], [4]. While experimental networks were conceived as heterogeneous from the very beginning, each manufacturer developed his own set of conventions for interconnecting his own equipments, referring to these as his "network architecture."

The universal need for interconnecting systems from different manufacturers rapidly became apparent [5], leading ISO to decide for the creation of SC16 with the objective to come up with standards required for "Open Systems Interconnection." The term "open" was chosen to emphasize the fact that by conforming to those international standards, a system will be open to all other systems obeying the same standards throughout the world.

The first meeting of SC16 was held in March 1978, and

initial discussions revealed [6] that a consensus could be reached rapidly on a layered architecture which would satisfy most requirements of Open Systems Interconnection with the capacity of being expanded later to meet new requirements. SC16 decided to give the highest priority to the development of a standard Model of Architecture which would constitute the framework for the development of standard protocols. After less than 18 months of discussions, this task was completed, and the ISO Model of Architecture called the Reference Model of Open Systems Interconnection [7] was transmitted by SC16 to its parent Technical Committee on "Data Processing" (TC97) along with recommendations to officially start a number of projects for developing on this basis an initial set of standard protocols for Open Systems Interconnection. These recommendations were adopted by TC97 at the end of 1979 as the basis for following development of standards for Open Systems Interconnection within ISO. The OSI Reference Model was also recognized by CCITT Rapporteur's Group on Public Data Network Services.

The present paper describes the OSI Architecture Model as it has been transmitted to TC97. Sections II-V introduce concepts of a layered architecture, along with the associated vocabulary defined by SC16. Specific use of those concepts in the OSI seven layers architecture are then presented in Section VI. Finally, some indications on the likely development of OSI standard protocols are given in Section VII.

Note on an "Interconnection Architecture"

The basic objective of SC16 is to standardize the rules of interaction between interconnected systems. Thus, only the external behavior of Open Systems must conform to OSI Architecture, while the internal organization and functioning of each individual Open System is out of the scope of OSI standards since these are not visible from other systems with which it is interconnected [8].

It should be noted that the same principle of restricted visibility is used in any manufacturer's network architecture in order to permit interconnection of systems with different structures within the same network.

These considerations lead SC16 to prefer the term of "Open Systems Interconnection Architecture" (OSIA) to the term of "Open Systems Architecture" which had been used previously and was felt to be possibly misleading. However, for unclear reasons, SC16 finally selected the title "Reference Model of Open Systems Interconnection" to refer to this Interconnection Architecture.

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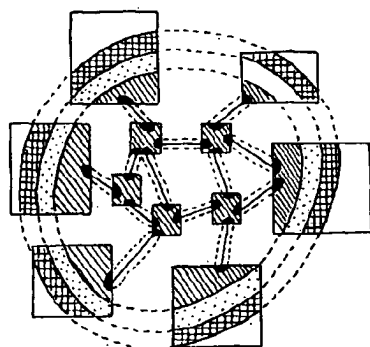


Fig. 1. Network layering.

II. GENERAL PRINCIPLES OF LAYERING

Layering is a structuring technique which permits the network of Open Systems to be viewed as logically composed of a succession of layers, each wrapping the lower layers and isolating them from the higher layers, as exemplified in Fig. 1.

An alternative but equivalent illustration of layering, used in particular by SC16 is given in Fig. 2 where successive layers are represented in a vertical sequence, with the physical media for Open Systems Interconnection at the bottom.

Each individual system itself is viewed as being logically composed of a succession of subsystems, each corresponding to the intersection of the system with a layer. In other words, a layer is viewed as being logically composed of subsystems of the same rank of all interconnected systems. Each subsystem is, in turn, viewed as being made of one or several entities. In other words, each layer is made of entities, each of which belongs to one system. Entities in the same layer are termed *peer* entities.

For simplicity, any layer is referred to as the (N) layer, while its next lower and next higher layers are referred to as the $(N - 1)$ layer and the $(N + 1)$ layer, respectively. The same notation is used to designate all concepts relating to layers, e.g., entities in the (N) layer are termed (N) entities, as illustrated in Figs. 3 and 4.

The basic idea of layering is that each layer adds value to services provided by the set of lower layers in such a way that the highest layer is offered the set of services needed to run distributed applications. Layering thus divides the total problem into smaller pieces. Another basic principle of layering is to ensure independence of each layer by defining services provided by a layer to the next higher layer, independent of how these services are performed. This permits changes to be made in the way a layer or a set of layers operate, provided they still offer the same service to the next higher layer. (A more comprehensive list of criteria for layering is given in Section VI.) This technique is similar to the one used in structured programming where only the functions performed by a module (and not its internal functioning) are known by its users.

Except for the highest layer which operates for its own purpose, (N) entities distributed among the interconnected Open Systems work collectively to provide the (N) service

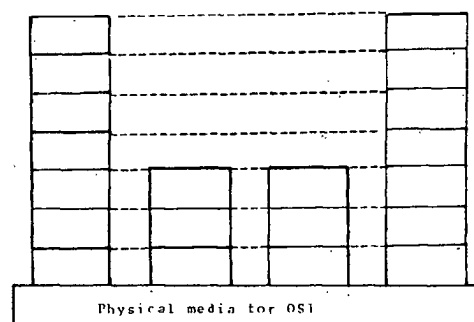


Fig. 2. An example of OSI representation of layering.

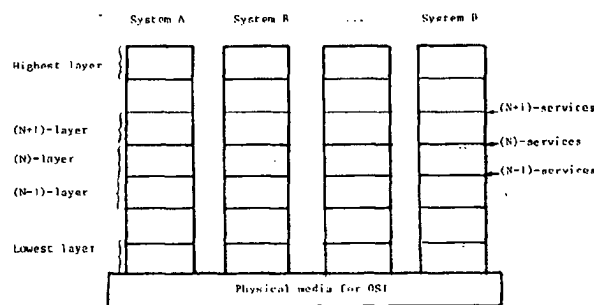


Fig. 3. Systems, layers, and services.

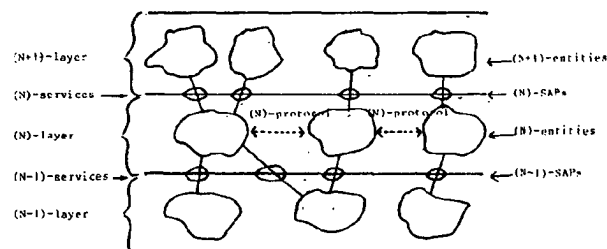


Fig. 4. Entities, service access points (SAP's), and protocols.

to $(N + 1)$ entities as illustrated in Fig. 4. In other words, the (N) entities add value to the $(N - 1)$ service they get from the $(N - 1)$ layer and offer this value-added service, i.e., the (N) service to the $(N + 1)$ entities.

Communication between the $(N + 1)$ entities make exclusive use of the (N) services. In particular, direct communication between the $(N + 1)$ entities in the same system, e.g., for sharing resources, is not visible from outside of the system and thus is not covered by the OSI Architecture. Entities in the lowest layer communicate through the Physical Media for OSI, which could be considered as forming the (0) layer of the OSI Architecture. Cooperation between the (N) entities is ruled by the (N) protocols which precisely define how the (N) entities work together using the $(N - 1)$ services to perform the (N) functions which add value to the $(N - 1)$ service in order to offer the (N) service to the $(N + 1)$ entities.

The (N) services are offered to the $(N + 1)$ entities at the (N) service access points, or (N) SAP's for short, which represent the logical interfaces between the (N) entities and the $(N + 1)$ entities. An (N) SAP can be served by only one

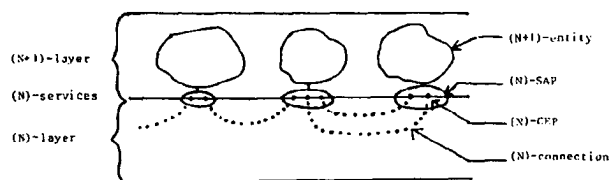


Fig. 5. Connections and connection endpoints (CEP's).

(N) entity and used by only one ($N + 1$) entity, but one (N) entity can serve several (N) SAP's and one ($N + 1$) entity can use several (N) SAP's.

A common service offered by all layers consists of providing associations between peer SAP's which can be used in particular to transfer data (it can, for instance, also be used to synchronize the served entities participating in the association). More precisely (see Fig. 5), the (N) layer offers (N) connections between (N) SAP's as part of the (N) services. The most usual type of connection is the *point-to-point* connection, but there are also *multiendpoint* connections which correspond to multiple associations between entities (e.g., broadcast communication). The end of an (N) connection at an (N) SAP is called an (N) connection endpoint or (N) CEP for short. Several connections may coexist between the same pair (or n -tuple) of SAP's.

Note: In the following, for the sake of simplicity, we will consider only point-to-point connections.

III. IDENTIFIERS

Objects within a layer or at the boundary between adjacent layers need to be uniquely identifiable, e.g., in order to establish a connection between two SAP's, one must be able to identify them uniquely. The OSI Architecture defines identifiers for entities, SAP's, and connections as well as relations between these identifiers, as briefly outlined below.

Each (N) entity is identified with a *global title*¹ which is unique and identifies the same (N) entity from anywhere in the network of Open Systems. Within more limited domains, an (N) entity can be identified with a *local title* which uniquely identifies the (N) entity only in the domain. For instance, within the domain corresponding to the (N) layer, (N) entities are identified with (N) *global titles* which are unique within the (N) layer.

Each (N) SAP is identified with an (N) *address* which uniquely identifies the (N)-SAP at the boundary between the (N) layer and the ($N + 1$) layer.

The concepts of titles and addresses are illustrated in Fig. 6.

Binding between (N) entities and the ($N - 1$) SAP's they use (i.e., SAP's through which they can access each other and communicate) are translated into the concept of (N) directory which indicates correspondence between global titles of (N) entities and (N) addresses through which they can be reached, as illustrated in Fig. 7.

¹ The term "title" has been preferred to the term "name" which is viewed as bearing a more general meaning. A title is equivalent to an entity name.

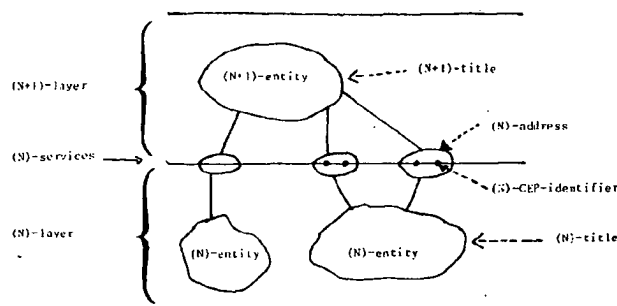


Fig. 6. Titles, addresses, and CEP-identifiers.

(N)-title	($N-1$)-address
A	352
B	237
B	015
C	015

Fig. 7. Example of an (N)-directory.

Correspondence between (N) addresses served by an (N) entity and the ($N - 1$) addresses used for this purpose is performed by an (N) mapping function. In addition to the simplest case of one-to-one mapping, mapping may, in particular, be hierarchical with the (N) address being made of an ($N - 1$) address and an (N) suffix. Mapping may also be performed "by table." Those three types of mapping are illustrated in Fig. 8.

Each (N) CEP is uniquely identified within its (N) SAP by an (N) CEP identifier which is used by the (N) entity and the ($N + 1$) entity on both sides of the (N) SAP to identify the (N) connection as illustrated in Fig. 6. This is necessary since several (N) connections may end at the same (N) SAP.

IV. OPERATION OF CONNECTIONS

A. Establishment and Release

When an ($N + 1$) entity requests the establishment of an (N) connection from one of the (N) SAP's it uses to another (N) SAP, it must provide at the local (N) SAP the (N) address of the distant (N) SAP. When the (N) connection is established, both the ($N + 1$) entity and the (N) entity will use the (N) CEP identifier to designate the (N) connection.

(N) connections may be established and released dynamically on top of ($N - 1$) connections. Establishment of an (N) connection implies the availability of an ($N - 1$) connection between the two entities. If not available, the ($N - 1$) connection must be established. This requires the availability of an ($N - 2$) connection. The same consideration applies downwards until an available connection is encountered.

In some cases, the (N) connection may be established simultaneously with its supporting ($N - 1$) connection provided

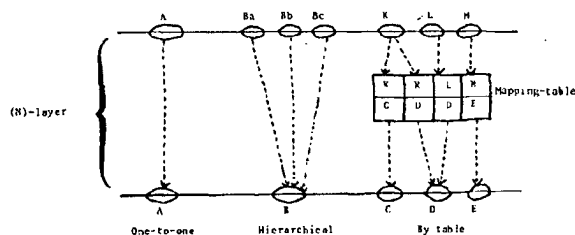


Fig. 8. Mapping between addresses.

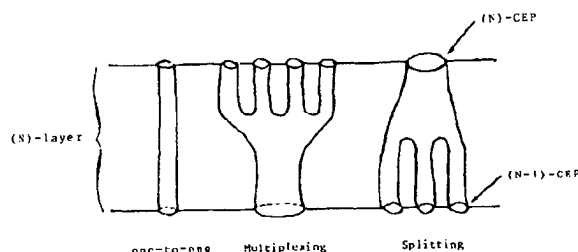


Fig. 9. Correspondence between connections.

the $(N - 1)$ connection establishment service permits (N) entities to exchange information necessary to establish the (N) connection.

B. Multiplexing and Splitting

Three particular types of construction of (N) connections on top of $(N - 1)$ connections are distinguished.

1) One-to-one correspondence where each (N) connection is built on one $(N - 1)$ connection.

2) Multiplexing (referred to as "upward multiplexing" in [7]) where several (N) connections are multiplexed on one single $(N - 1)$ connection.

3) Splitting (referred to as "downward multiplexing" in [7]) where one single (N) connection is built on top of several $(N - 1)$ connection, the traffic on the (N) connection being divided between the various $(N - 1)$ connections.

These three types of correspondence between connections in adjacent layers are illustrated in Fig. 9.

C. Data Transfer

Information is transferred in various types of data units between peer entities and between entities attached to a specific service access point. The data units are defined below and the interrelationship among several of them is illustrated in Fig. 10.

(N) Protocol Control Information is information exchanged between two (N) entities, using an $(N - 1)$ connection, to coordinate their joint operation.

(N) User Data is the data transferred between two (N) entities on behalf of the $(N + 1)$ entities for whom the (N) entities are providing services.

An (N) Protocol Data Unit is a unit of data which contains (N) Protocol Control Information and possibly (N) User Data.

(N) Interface Control Information is information exchanged between an $(N + 1)$ entity and an (N) entity to coordinate their joint operation.

(N) Interface Data is information transferred from an $(N + 1)$ entity to an (N) entity for transmission to a correspondent $(N + 1)$ entity over an (N) connection, or conversely, information transferred from an (N) entity to an $(N + 1)$ entity which has been received over an (N) connection from a correspondent $(N + 1)$ entity.

(N) Interface Data Unit is the unit of information transferred across the service access point between an $(N + 1)$ entity and an (N) entity in a single interaction. The size of (N)

	Control	Data	Combined
$(N) - (N)$ Peer Entities	(N) -Protocol- Control-Information	(N) -User-Data	(N) -Protocol-Data- Units
$(N) - (N - 1)$ Adjacent Layers	$(N - 1)$ -Interface- Control- Information	$(N - 1)$ -Interface- Data	$(N - 1)$ -Interface- Data-Unit

Fig. 10. Interrelationship between data units.

interface data units is not necessarily the same at each end of the connection.

$(N - 1)$ Service Data Unit is the amount of $(N - 1)$ interface data whose identity is preserved from one end of an $(N - 1)$ connection to the other. Data may be held within a connection until a complete service data unit is put into the connection.

Expedited $(N - 1)$ service data unit is a small $(N - 1)$ service data unit whose transfer is expedited. The $(N - 1)$ layer ensures that an expedited data unit will not be delivered after any subsequent service data unit or expedited data unit sent on that connection. An expedited $(N - 1)$ service data unit may also be referred to as an $(N - 1)$ expedited data unit.

Note: An (N) protocol data unit may be mapped one-to-one onto an $(N - 1)$ service data unit (see Fig. 11).

V. MANAGEMENT ASPECTS

Even though a number of resources are managed locally, i.e., without involving cooperation between distinct systems, some management functions do.

Examples of such management functions are

configuration information,
cold start/termination,
monitoring,
diagnostics,
reconfiguration, etc.

The OSI Architecture considers management functions as applications of a specific type. Management entities located in the highest layer of the architecture may use the complete set of services offered to all applications in order to perform

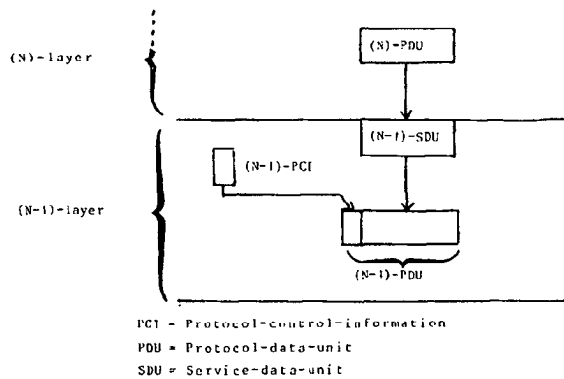


Fig. 11. Logical relationship between data units in adjacent layers.

management functions. This organization of management functions within the OSI Architecture is illustrated in Fig. 12.

VI. THE SEVEN LAYERS OF THE OSI ARCHITECTURE

A. Justification of the Seven Layers

ISO determined a number of principles to be considered for defining the specific set of layers in the OSI architecture, and applied those principles to come up with the seven layers of the OSI Architecture.

Principles to be considered are as follows.

- 1) Do not create so many layers as to make difficult the system engineering task describing and integrating these layers.
- 2) Create a boundary at a point where the services description can be small and the number of interactions across the boundary is minimized.
- 3) Create separate layers to handle functions which are manifestly different in the process performed or the technology involved.
- 4) Collect similar functions into the same layer.
- 5) Select boundaries at a point which past experience has demonstrated to be successful.
- 6) Create a layer of easily localized functions so that the layer could be totally redesigned and its protocols changed in a major way to take advantages of new advances in architectural, hardware, or software technology without changing the services and interfaces with the adjacent layers.
- 7) Create a boundary where it may be useful at some point in time to have the corresponding interface standardized.
- 8) Create a layer when there is a need for a different level of abstraction in the handling of data, e.g., morphology, syntax, semantics.
- 9) Enable changes of functions or protocols within a layer without affecting the other layers.
- 10) Create for each layer interfaces with its upper and lower layer only.
- 11) Create further subgrouping and organization of functions to form sublayers within a layer in cases where distinct communication services need it.
- 12) Create, where needed, two or more sublayers with a

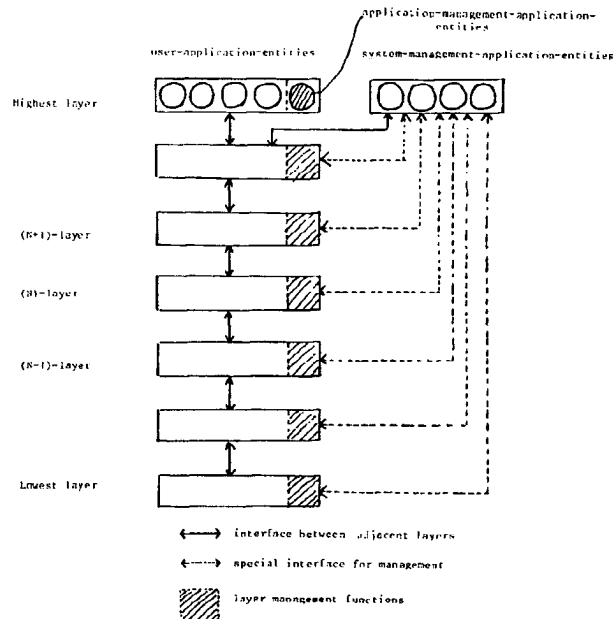


Fig. 12. A representation of management functions.

common, and therefore minimum, functionality to allow interface operation with adjacent layers.

- 13) Allow bypassing of sublayers.

B. Specific Layers

The following is a brief explanation of how the layers were chosen.

1) It is essential that the architecture permits usage of a realistic variety of physical media for interconnection with different control procedures (e.g., V.24, V.35, X.21, etc.). Application of principles 3, 5, and 8 leads to identification of a *Physical Layer* as the lowest layer in the architecture.

2) Some physical communications media (e.g., telephone line) require specific techniques to be used in order to transmit data between systems despite a relatively high error rate (i.e., an error rate not acceptable for the great majority of applications). These specific techniques are used in data-link control procedures which have been studied and standardized for a number of years. It must also be recognized that new physical communications media (e.g., fiber optics) will require different data-link control procedures. Application of principles 3, 5, and 8 leads to identification of a *Data link Layer* on top of the Physical Layer in the architecture.

3) In the Open Systems Architecture, some systems will act as final destination of data. Some systems may act only as intermediate nodes (forwarding data to other systems). Application of principles 3, 5, and 7 leads to identification of a *Network Layer* on top of the Data link Layer. Network-oriented protocols such as routing, for example, will be grouped in this layer. Thus, the Network Layer will provide a connection path (network connection) between a pair of transport entities (see Fig. 13).

4) Control of data transportation from source end system to destination end system (which need not be performed in

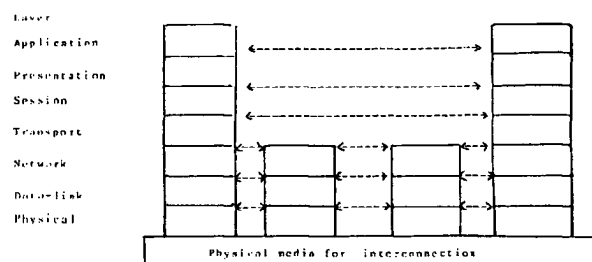


Fig. 13. The seven layers OSI architecture.

intermediate nodes) is the last function to be performed in order to provide the totality of the transport service. Thus, the upper layer in the transport-service part of the architecture is the *Transport Layer*, sitting on top of the *Network Layer*. This *Transport Layer* relieves higher layer entities from any concern with the transportation of data between them.

5) In order to bind/unbind distributed activities into a logical relationship that controls the data exchange with respect to synchronization and structure, the need for a dedicated layer has been identified. So the application of principles 3 and 4 leads to the establishment of the *Session Layer* which is on top of the *Transport Layer*.

6) The remaining set of general interest functions are those related to representation and manipulation of structured data for the benefit of application programs. Application of principles 3 and 4 leads to identification of a *Presentation Layer* on top of the *Session Layer*.

7) Finally, there are applications consisting of application processes which perform information processing. A portion of these application processes and the protocols by which they communicate comprise the *Application Layer* as the highest layer of the architecture.

The resulting architecture with seven layers, illustrated in Fig. 13 obeys principles 1 and 2.

A more detailed definition of each of the seven layers identified above is given in the following sections, starting from the top with the application layer described in Section VI-C1) down to the physical layer described in Section VI-C7).

C. Overview of the Seven Layers of the OSI Architecture

1) *The Application Layer*: This is the highest layer in the OSI Architecture. Protocols of this layer directly serve the end user by providing the distributed information service appropriate to an application, to its management, and to system management. Management of Open Systems Interconnection comprises those functions required to initiate, maintain, terminate, and record data concerning the establishment of connections for data transfer among application processes. The other layers exist only to support this layer.

An application is composed of cooperating *application processes* which intercommunicate according to application layer protocols. Application processes are the ultimate source and sink for data exchanged.

A portion of an application process is manifested in the application layer as the execution of application protocol (i.e., application entity). The rest of the application process

is considered beyond the scope of the present layered model. Applications or application processes may be of any kind (manual, computerized, industrial, or physical).

2) *The Presentation Layer*: The purpose of the *Presentation Layer* is to provide the set of services which may be selected by the *Application Layer* to enable it to interpret the meaning of the data exchanged. These services are for the management of the entry exchange, display, and control of structured data.

The presentation service is location-independent and is considered to be on top of the *Session Layer* which provides the service of linking a pair of presentation entities.

It is through the use of services provided by the *Presentation Layer* that applications in an Open Systems Interconnection environment can communicate without unacceptable costs in interface variability, transformations, or application modification.

3) *The Session Layer*: The purpose of the *Session Layer* is to assist in the support of the interactions between cooperating presentation entities. To do this, the *Session Layer* provides services which are classified into the following two categories.

a) Binding two presentation entities into a relationship and unbinding them. This is called *session administration service*.

b) Control of data exchange, delimiting, and synchronizing data operations between two presentation entities. This is called *session dialogue service*.

To implement the transfer of data between presentation entities, the *Session Layer* may employ the services provided by the *Transport Layer*.

4) *The Transport Layer*: The *Transport Layer* exists to provide a universal transport service in association with the underlying services provided by lower layers.

The *Transport Layer* provides transparent transfer of data between session entities. The *Transport Layer* relieves these session entities from any concern with the detailed way in which reliable and cost-effective transfer of data is achieved.

The *Transport Layer* is required to optimize the use of available communications services to provide the performance required for each connection between session entities at a minimum cost.

5) *The Network Layer*: The *Network Layer* provides functional and procedural means to exchange network service data units between two transport entities over a network connection. It provides transport entities with independence from routing and switching considerations.

6) *The Data Link Layer*: The purpose of the *Data link Layer* is to provide the functional and procedural means to establish, maintain, and release data links between network entities.

7) *The Physical Layer*: The *Physical Layer* provides mechanical, electrical, functional, and procedural characteristics to establish, maintain, and release physical connections (e.g., data circuits) between data link entities.

VII. OSI PROTOCOLS DEVELOPMENTS

The model of OSI Architecture defines the services provided by each layer to the next higher layer, and offers con-

cepts to be used to specify how each layer performs its specific functions.

Detailed functioning of each layer is defined by the protocols specific to the layer in the framework of the Architecture model.

Most of the initial effort within ISO has been placed on the model of OSI. The next step consists of the definition of standard protocols for each layer.

This section contains a brief description of a likely initial set of protocols, corresponding to specific standardization projects recommended by SC16.

A. Protocols in the Physical Layer

Standards already exist within CCITT defining:

- 1) interfaces with physical media for OSI, and
- 2) protocols for establishing, controlling, and releasing switched data circuits.

Such standards are described in other papers in this issue [9], [10], e.g., X.21, V.24, V.35, etc.

The only work to be done will consist of clearly relating those standards to the OSI Architecture model.

B. Protocols in the Data Link Layer

Standard protocols for the Data link Layer have already been developed within ISO, which are described in other papers within this issue [11], [12].

The most popular Data link Layer protocol is likely to be HDLC [13], without ruling out the possibility of using also other character-oriented standards.

Just as for the Physical Layer, the remaining work will consist mainly of clearly relating these existing standards to the OSI Architecture model.

C. Protocols in the Network Layer

An important basis for protocols in the network layer is level 3 of the X.25 interface [14] defined by CCITT and described in another paper in this issue. It will have to be enhanced in particular to permit interconnection of private and public networks.

Other types of protocols are likely to be standardized later in this layer, and in particular, protocols corresponding to Datagram networks [10].

D. Protocols in the Transport Layer

No standard exists at present for this layer; a large amount of experience has been accumulated in this area and several proposals are available.

The most widely known proposal is the Transport Protocol proposed by IFIP and known as INWG 96.1 [15], which could serve as a basis for defining an international standard.

E. Protocols for the Session Layer

No standard exists and no proposal has been currently available, since in most networks, session functions were often considered as part of higher layer functions such as Virtual Terminal and File Transfer.

A standard Session Layer Protocol can easily be extracted from existing higher layer protocols.

F. Presentation Layer Protocol

So far, Virtual Terminal Protocols and part of Virtual File are considered the most urgent protocols to be developed in the Presentation Layer.

A number of VTP's are available (e.g., [16], [17]), many of them being very similar, and it should be easy to derive a Standard VTP from these proposals, also making use of the ISO standard for "Extended Control Characters for I/O Imaging Devices" [18]. These protocols are reviewed in another paper in this issue [19].

The situation is similar for File Transfer Protocols.

G. Management Protocols

Most of the work within ISO has been done so far on the architecture of management functions, and very little work has been done on management protocols themselves. Therefore, it is too early to give indications on the likely results of the ISO work in this area.

VIII. CONCLUSION

The development of OSI Standards is a very big challenge, the result of which will impact all future computer communication developments. If standards come too late or are inadequate, interconnection of heterogeneous systems will not be possible or will be very costly.

The work collectively achieved so far by SC16 members is very promising, and additional efforts should be expended to capitalize on these initial results and come up rapidly with the most urgently needed set of standards which will support initial usage of OSI (mainly terminals accessing services and file transfers). The next set of standards, including OSI management and access to distributed data, will have to follow very soon.

Common standards between ISO and CCITT are also essential to the success of standardization, since new services announced by PTT's and common carriers are very similar to data processing services offered as computer manufacturer products, and duplication of now compatible standards could simply cause the standardization effort to fail. In this regard, acceptance of the OSI Reference Model by CCITT Rapporteur's Group on Layered Architecture for Public Data Networks Services is most promising.

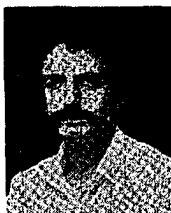
It is essential that all partners in this standardization process expend their best effort so it will be successful, and the benefits can be shared by all users, manufacturers of terminals and computers, and the PTT's/common carriers.

ACKNOWLEDGMENT

The OSI Architecture model briefly described in this paper results from the work of more than 100 experts from many countries and international organizations. Participation in this collective work was really a fascinating experience for the author who acknowledges the numerous contributions from SC16 members which have been merged in the final version of the OSI Architecture briefly presented here.

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- [19] J. Day, "Terminal protocols," this issue, pp. 585-593.



Hubert Zimmermann received degrees in engineering from Ecole Polytechnique, Paris, France, in 1963, and from Ecole Nationale Supérieure des Télécommunications, Paris, France, in 1966.

He is presently in charge of the computer communications group at IRIA, Rocquencourt, France. He was involved in development of command and control systems before joining IRIA in 1972 to start the CYCLADES project with L. Pouzin. Within CYCLADES, he was mainly responsible for design and implementation of host protocols.

Dr. Zimmermann is a member of IFIP WG 6.1 [International Network Working Group (INWG)]. He also chaired the Protocol Subgroup and co-authored several proposals for international protocols. He is an active participant in the development of standards for Open Systems Interconnection (OSI) within ISO, where he chairs the working group on OSI architecture.

Exhibit 17

IEEE Std 100-1996

The IEEE Standard Dictionary of Electrical and Electronics Terms

Sixth Edition

**Standards Coordinating Committee 10, Terms and Definitions
Jane Radatz, Chair**

This standard is one of a number of information technology dictionaries being developed by standards organizations accredited by the American National Standards Institute. This dictionary was developed under the sponsorship of voluntary standards organizations, using a consensus-based process.

ISBN 1-55937-833-6



photovoltaic system-utility interface

774

physical layer entity

photovoltaic system-utility interface (terrestrial photovoltaic power systems) The interconnection between the power conditioning subsystem, the on-site ac loads, and the utility. *Synonym:* PV system-utility interface. *See also:* array control. (PV) 928-1986r

PhPDU *See:* physical protocol data unit.

PHR *See:* physical record.

PhSDU *See:* physical interface data unit.

PhSDU *See:* physical protocol service unit; physical service data unit.

PhS>User *See:* physical service user.

PHY Abbreviation for physical. *See also:* physical layer. (C/LM) 802.5-1989s

PHY layer *See:* physical layer.

PHY packet A packet either generated or received by the cable physical layer. These packets are always exactly 64 bits long where the last 32 bits are the bit complement of the first 32 bits. (C/MM) 1394-1995

physical (data management) Pertaining to the representation and storage of data on a data medium such as magnetic disk, or to characteristics of the data such as the length of data elements or records. *Contrast:* logical. (C) 610.5-1990

physical address (1) A unique identifier that selects a particular device from the set of all devices connected to a particular bus. (BA/C) 1275-1994

(2) The address of a data item in physical memory. *See also:* virtual address. (C) 610.10-1994

physical address space The set of possible physical addresses for a particular bus. (BA/C) 1275-1994

physical architecture An arrangement of physical elements that provides the design solution for a consumer product or life-cycle process intended to satisfy the requirements of the functional architecture and the requirements baseline. (C/SE) 1220-1994

physical characteristics The physical design attributes or distinguishing features that pertain to a measurable description of a product or process. (C/SE) 1220-1994

physical child segment In a hierarchical database, a child segment in a physical database. *See also:* logical child segment. (C) 610.5-1990

physical circuit (data transmission) A two-wire metallic circuit that is not arranged for phantom use. (PE) 599-1985w

physical coding sublayer (PCS) A sublayer used in 100BASE-T to couple the MII and the PMA. The PCS contains the functions to encode data bits into code-groups that can be transmitted over the physical medium. Two PCS structures are defined for 100BASE-T—one for 100BASE-X and one for 100BASE-T4. (C/LM) 802.3u-1995

physical concept Anything that has existence or being in the ideas of man pertaining to the physical world. Examples are magnetic fields, electric currents, electrons. (Std100) 270-1966w

physical configuration audit (software) An audit conducted to verify that a configuration item, as built, conforms to the technical documentation that defines it. *See also:* functional configuration audit. (C) 610.12-1990

physical connection The full-duplex physical layer association between directly connected nodes. In the case of the cable physical layer, this is a pair of physical links running in opposite directions. (C/MM) 1394-1995

physical damage (rotating machinery) This contributes to electrical insulation failure by opening leakage paths through the insulation. Included here are: physical shock, vibration, overspeed, short-circuit forces, erosion by foreign matter, damage by foreign objects, and thermal cycling. (PE) 432-1976s

physical database (A) (data management) A database as it is actually stored. (B) (data management) A database containing a collection of related segments or records that are physically stored together. *Note:* Segments within a physical data-

base are known as physical segments. *Contrast:* logical database. (C) 610.5-1990

physical data model (data management) A data model that represents the implementation of the data contained in a data structure. *Contrast:* logical data model. (C) 610.5-1990

physical defect *See:* fault.

physical element A product, subsystem, assembly, component, subcomponent, subassembly, or part of the physical architecture defined by its designs, interfaces (internal and external), and requirements (functional, performance, constraints, and physical characteristics). (C/SE) 1220-1994

physical entity *See:* physical quantity.

physical format *See:* low-level format.

physical_ID The least-significant 6 bits of the node_ID. This number is unique on a particular bus and is chosen by the physical layer during initialization. (C/MM) 1394-1995

physical interface (1) The circuitry that interfaces the module, board(s), and node(s) to the bus signals. (C/MM) 1212-1991s

(2) The circuitry that interfaces a module's nodes to the input link, output link, and miscellaneous signals. (C/MM) 1596-1992, 1596.3-1996

physical interface data unit (PhSDU) An octet (8 data bits) that is communicated across the interface between a BCC or a DCC Physical layer and Data Link layer. (EMB) 1073.3.1-1994

physical layer (1) (Layer 1) The layer of the ISO Reference Model that provides the mechanical, electrical, functional, and procedural characteristics access to the transmission medium. (C/DIS) 1278.2-1995

(2) In this part of ISO/IEC 8802, the subdivision that provides the protocol to allow transfer of *slot octets*, *management information octets*, and *DQDB Layer* timing information over the *transmission link* between *DQDB Layer subsystems* at adjacent *nodes*. The Physical Layer provides the service to the *DQDB Layer*. (C/LM) 8802-6-1994

(3) The first layer of the seven-layer OSI model; responsible for transporting bits between adjacent systems. *Note:* This layer accepts a bit stream, called a frame, from the data link layer and places it on the media. It also performs the inverse operation of extracting a bit stream from the physical media and passes it to the data link layer. This layer describes mechanical and electrical characteristics of the connection, as well as the required interchange circuits. *See also:* application layer; client layer; data link layer; entity layer; logical link control sublayer; medium access control (MAC) sublayer; network layer; presentation layer; session layer; sublayer; transport layer. (C) 610.7-1995

(4) The layer, in a stack of three protocol layers defined for the Serial Bus, that translates the logical symbols used by the link layer into electrical signals on the different Serial Bus media. The physical layer guarantees that only one node at a time is sending data and defines the mechanical interfaces for the Serial Bus. There are different physical layers for the backplane and for the cable environment. See figure 34 for the relation of the physical layer to the Serial Bus protocol stack. (C/MM) 1394-1995

(5) The layer responsible for interfacing with the transmission medium. This includes conditioning signals received from the MAC for transmitting to the medium and processing signals received from the medium for sending to the MAC. (C/LM) 8802-5-1995

physical layer convergence procedure (PLCP) The part of the *Physical Layer* that supports the transfer of *slot octets*, *management information octets*, and *DQDB Layer* timing information in a manner that adapts the capabilities of the *transmission system* to the service expected by the *DQDB Layer*. (C/LM) 8802-6-1994

physical layer entity The portion of the Physical Layer between the MDI and MII consisting of the PCS, PMA, and, if present, PMD sublayers. The PHY contains the functions that transmit, receive, and manage the encoded signals that are im-

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Exhibit 18



Handwritten: #6M
Annot B
PATENT 11-3-97

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of:
Robert Scott

Serial No.: 08/780,762

Art Unit: 2614

Filed: January 8, 1997

Examiner: J. Gluck

For: PRESETTING LINK LAYER
PARAMETERS PER PHYSICAL
LAYER STARTUP

Docket: 061605-0590

FIRST RESPONSE WITH AMENDMENTS

Assistant Commissioner for Patents
Box Amendments
Washington, DC 20231

Atlanta, GA
October 23, 1997

Sir:

In response to the nonfinal Office Action of September 12, 1997, (Paper No. 4), Applicant submits the following response with amendments and remarks.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those which may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 C.F.R. § 1.136(a), and any fees required therefor (including fees for net addition of claims) are hereby authorized to be charged to Paradyne Corporation's Fee Deposit Account No. 16-0255.

Certificate of Mailing

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope, with sufficient postage, addressed to: Assistant Commissioner for Patents, Box Amendments, Washington, D.C. 20231 on Oct. 23, 1997

Signature: [Signature]

IN THE SPECIFICATION

- Page 2, line 1, delete "exists" and replace with --exist--.
- Page 3, line 22, delete "a".
- Page 6, line 21, delete "significance" and replace with --significant--.
- Page 7, line 18, delete "obtain" and replace with --obtaining--.
- Page 7, line 18, after "T1" and before "to" add --connection--.
- Page 8, line 7, delete "modem" and replace with --modems--.
- Page 9, line 22, delete "modem" and replace with --modems--.
- Page 12, line 8, delete "cancellor" and replace with --cancellers--.
- Page 12, line 19, delete "The" and replace with --This--.
- Page 13, line 10, delete the phrase "with certain designed implications that".
- Page 14, lines 9-12, delete the phrase "Alternatively, if the calling modem detects the ANS answer signal (2100 hz) in block 86, then it communicates with the answer modem using the ETC 1TM communication protocol and the V.32bis training in block 87. If the ANSam answer signal is detected at block 88, then it communicates in V.34 mode as indicated in block 89."
- Page 14, line 21, delete the phrase "not. As" and replace with --not, as--.
- Page 14, line 22, delete the phrase "install time." and replace with --installation--.
- Page 14, line 30, delete "assume" and replace with --assumes--.
- Page 15, line 20, delete "establish" and replace with --established--.
- Page 16, line 7, delete "INFO," and replace with --INFO sequences,--.
- Page 18, line 11, delete the first occurrence of "the".
- Page 19, lines 6-7, delete the phrase "used other than those disclosed herein." and replace with --used--.
- Page 23, line 4, delete the first occurrence of "a" and replace with --an--.

IN THE CLAIMS

Amend the following pending claims by deleting that language which is enclosed within brackets ("[]") and by inserting that language which is underlined ("___").

- B1
1. (Once Amended) A method for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and a plurality of possible link layer connections and an answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections, comprising the steps of:
- establishing a physical layer connection between said calling and said answering modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations; and
- establishing said link layer connection based upon said negotiated physical layer modulation.

IN THE DRAWINGS

[

The drawings are sought to be amended to comply with requirements made in the outstanding Office Action. In accordance with 37 C.F.R. §1.123, proposed changes to the drawings are indicated in red ink on separate pages accompanying this amendment.

REMARKS

This is in full and timely response to the nonfinal Office Action of September 12, 1997. Reexamination, reconsideration, and allowance of the application and all presently pending claims are respectfully requested.

Upon entry of this Amendment, claims 1-10 remain pending in this application. Furthermore, amendments to Fig. 6 and Fig. 7 have been submitted herewith. Fig. 6 has been amended to correct for a minor clerical error, and Fig. 7 has been amended to comply with a requirement for correction by the Examiner. It is believed that the foregoing amendments and additions add no new matter to the present application.

Objection to Drawings

Fig. 7 is objected to in the Office Action as containing the term "WDG" which is not specified in the specification. An amendment to Fig. 7 has been submitted herewith, and it is believed that Fig. 7, as amended, complies with the Examiner's requirement for correction.

Claim Rejections

A proper rejection of a claim under 35 U.S.C. §102 requires that a single prior art reference disclose each element of the claim. See, e.g., *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 U.S.P.Q. 303, 313 (Fed. Cir. 1983). Furthermore, in order for a claim to be properly rejected under 35 U.S.C. §103, the combined teachings

of the references must suggest all features of the claimed invention to one of ordinary skill in the art. See, e.g., *In Re Dow Chemical*, 5 U.S.P.Q.2d 1529, 1531 (Fed. Cir. 1988), and *In re Keller*, 208 U.S.P.Q.2d 871, 881 (C.C.P.A. 1981). However, a reference teaches away from the claimed invention and should not be used under 35 U.S.C. §103 if “a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant.” *In re Gurley*, 2 F.3d 551, 31 U.S.P.Q.2d 1130, 1131 (Fed Cir. 1994).

Rejections under *Abbie*

Claim 1

Claim 1 presently stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *Abbie*. Claim 1 reads as follows:

1. A method for establishing a link layer connection between a calling modem having a plurality of possible first physical layer modulations and a plurality of possible link layer connections and an answering modem having a plurality of possible second physical layer modulations and a plurality of possible second link layer connections, comprising the steps of:

establishing a physical layer connection between said calling and said answering modems, wherein said physical layer connection is based on a negotiated physical layer modulation chosen from said first and second physical layer modulations;
and

establishing said link layer connection based upon said negotiated physical layer modulation. (Emphasis added)

Applicant respectfully asserts that *Abbie* does not teach the features of pending claim

1. In particular, *Abbie* fails to suggest or teach at least the concept of establishing a

physical layer that “is based on a negotiated physical layer modulation” chosen from various physical layer modulations as defined by the highlighted portion of pending claim 1 hereinabove.

In establishing a physical layer in one embodiment of the present invention, a calling modem transmits a calling signal to an answer modem. See Page 9, line 17, through Page 10, line 2. The answer modem uses the calling signal to recognize that the calling modem is capable of fast connection, and the answer modem notifies the calling modem whether the answer modem is capable of fast connection. See Page 10, line 21, through Page 11, line 14. Moreover, physical layer modulation with fast connection protocol is chosen only if both modems are capable of fast connection. If either one of the two modems is incapable of fast connection, a different type of physical layer modulation is chosen. See Page 11, line 23, through Page 12, line 27. By choosing a physical layer modulation based on the capabilities of the two modems as determined at run time, the two modems “negotiate” an appropriate physical layer modulation scheme.

Abbie, on the other hand, **commands** the answer modem to perform a fast connect. Col. 4, lines 18-21, and Col. 4, lines 31-34. There is no negotiation wherein the calling modem accommodates the incapability of the answer modem to carry out a fast connect command. The answer modem simply responds to the calling modem, and there is nothing in *Abbie* to suggest a negotiating system or method. Therefore, *Abbie* fails to teach the feature of having a physical layer connection based on “a negotiated physical layer modulation.”

Furthermore, since the answer modem in *Abbie* must respond to a fast connect command, *Abbie* teaches that each computer should have a modem with “a fast modem connect protocol.” Col. 4, lines 14-17. This teaches away from the present invention which allows modems with different connection speeds to establish a mutually acceptable protocol. Applicant respectfully submits that one of ordinary skill in the art, upon reading *Abbie*, would be discouraged from using *Abbie* to implement a negotiating system or method since *Abbie* specifically teaches using modems having fast connect capabilities. Accordingly, under the principles of *In re Gurley*, *Abbie* should not be used to render the present invention obvious.

Because *Abbie* teaches away from the present invention and fails to disclose or suggest a physical layer connection “based on a negotiated physical layer modulation” chosen from various physical layer modulations, *Abbie* fails to anticipate the present invention under 35 U.S.C. §102 or, in the alternative, to render the present invention obvious under 35 U.S.C. §103.

Claims 2-5

Claims 2-5 presently stand rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *Abbie*. Applicant submits that the pending dependent claims 2-5 contain all features of their respective independent claim 1. Since claim 1 should be allowed, as argued hereinabove, pending dependent claims 2-5 should be allowed as a matter of law for at least this reason. *In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988). Furthermore, these dependent claims recite

patentably distinct features and/or combinations of features not discussed herein that make them allowable, notwithstanding the allowability of their base claim 1.

Claim 6

Claim 6 presently stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *Abbie*. However, similar to claim 1, claim 6 contains a “means for establishing a physical layer connection ... wherein said physical layer connection is based on a negotiated physical modulation chosen from” various physical layer modulations. Accordingly, for at least the reasons argued hereinabove in the analysis to pending claim 1, claim 6, as presently set forth, is allowable. Furthermore, pending claim 6 recites other patentably distinct features and/or combinations of features not discussed herein that make claim 6 allowable.

Claims 7-9

Claims 7-9 presently stand rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *Abbie*. Applicant submits that the pending dependent claims 7-9 contain all features of their respective independent claim 6. Since claim 6 should be allowed, as argued hereinabove, pending dependent claims 7-9 should be allowed as a matter of law for at least this reason. *In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988). Furthermore, these dependent claims recite patentably distinct features and/or combinations of features not discussed herein that make them allowable, notwithstanding the allowability of their base claim 6.

Claim 10

Claim 10 presently stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *Abbie*. However, similar to claim 1, claim 10 contains the feature of “establishing a physical layer connection ... wherein said physical layer connection is based on a negotiated physical modulation chosen from” various physical layer modulations. Accordingly, for at least the reasons argued hereinabove in the analysis to pending claim 1, claim 10, as presently set forth, is allowable. Furthermore, pending claim 10 recites other patentably distinct features and/or combinations of features not discussed herein that make claim 10 allowable.

Rejections under *McGlynn*Claim 1

Claim 1 also stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *McGlynn*. However, Applicant respectfully asserts that *McGlynn* also fails to teach at least the feature in pending claim 1 of “establishing a physical layer connection...based on a negotiated physical layer modulation chosen from said first and second physical layer modulations.”

There are two phases in establishing a physical layer connection. First, there is an automatic mode synchronization phase, and then there is a modem training and startup phase. See Page 9, lines 4-22, and Fig. 2 of the present invention. Physical layer modulation is determined during the first phase, the automatic mode

synchronization phase. See Page 15, lines 18-23, and Figs. 4, 5, 6, and 7. Therefore, the training and startup sequence is performed subsequent to the negotiation of a physical layer modulation scheme.

McGlynn negotiates for a listing of common features “after completing conventional or standard handshaking sequences.” See Abstract and Col. 8, lines 2-5. Applicant submits that the “conventional or standard handshaking sequences” referred to by *McGlynn* are the handshaking sequences performed in the modem training and startup sequence disclosed in Fig. 2 of the present invention. This is supported by comparing the automatic mode synchronization phase described by the present invention (See Fig. 2, Fig. 3 and Page 9, line 23, through Page 11, line 14) to the teachings of *McGlynn* referring to the timing of the negotiation period. Col. 8, lines 21-41. Since the negotiations in *McGlynn* occur subsequent to the “conventional or standard handshaking sequences” of the training and start up sequence, then the negotiations in *McGlynn* necessarily occur subsequent to the establishment of physical layer modulation which, as indicated hereinabove, occurs prior to the training and start up sequence.

Accordingly, the negotiations in *McGlynn*, unlike the negotiations in pending claim 1, fail to include the negotiation of physical layer modulation. Instead, the negotiations taught in *McGlynn* only determine which features can be subsequently used by the two modems once a physical layer modulation has already been established. See Col. 3, lines 51-56. As a result, *McGlynn* fails to teach or suggest

the negotiation of physical layer modulation as described in pending claim 1, and *McGlynn* should not be used to reject claim 1.

For at least the foregoing reasons, claim 1, as presently set forth, is allowable.

Claims 2-5

Claims 2-5 presently stand rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *McGlynn*. Applicant submits that the pending dependent claims 2-5 contain all features of their respective independent claim 1. Since claim 1 should be allowed, as argued hereinabove, pending dependent claims 2-5 should be allowed as a matter of law for at least this reason. *In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988). Furthermore, these dependent claims recite patentably distinct features and/or combinations of features not discussed herein that make them allowable, notwithstanding the allowability of their base claim 1.

Claim 6

Claim 6 presently stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *McGlynn*. However, similar to claim 1, claim 6 contains a “means for establishing a physical layer connection ... wherein said physical layer connection is based on a negotiated physical modulation chosen from” various physical layer modulations. Accordingly, for at least the reasons argued hereinabove in the analysis to pending claim 1, claim 6, as presently set forth,

is allowable. Furthermore, pending claim 6 recites other patentably distinct features and/or combinations of features not discussed herein that make claim 6 allowable.

Claims 7-9

Claims 7-9 presently stand rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *McGlynn*. Applicant submits that the pending dependent claims 7-9 contain all features of their respective independent claim 6. Since claim 6 should be allowed, as argued hereinabove, pending dependent claims 7-9 should be allowed as a matter of law for at least this reason. *In re Fine*, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988). Furthermore, these dependent claims recite patentably distinct features and/or combinations of features not discussed herein that make them allowable, notwithstanding the allowability of their base claim 6.

Claim 10

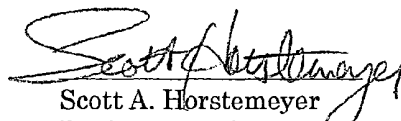
Claim 10 presently stands rejected under 35 U.S.C. §102 and 35 U.S.C. §103 as being anticipated by or, in the alternative, obvious to *McGlynn*. However, similar to claim 1, claim 10 contains the feature of “establishing a physical layer connection ... wherein said physical layer connection is based on a negotiated physical modulation chosen from” various physical layer modulations. Accordingly, for at least the reasons argued hereinabove in the analysis to pending claim 1, claim 10, as presently set forth, is allowable. Furthermore, pending claim 10 recites other patentably distinct

features and/or combinations of features not discussed herein that make claim 10 allowable.

CONCLUSION

Applicant respectfully requests that all outstanding objections and rejections be withdrawn and that this application and all presently pending claims be allowed to issue. If the Examiner has any comments regarding Applicant's response, the Examiner is encouraged to telephone Applicant's undersigned counsel.

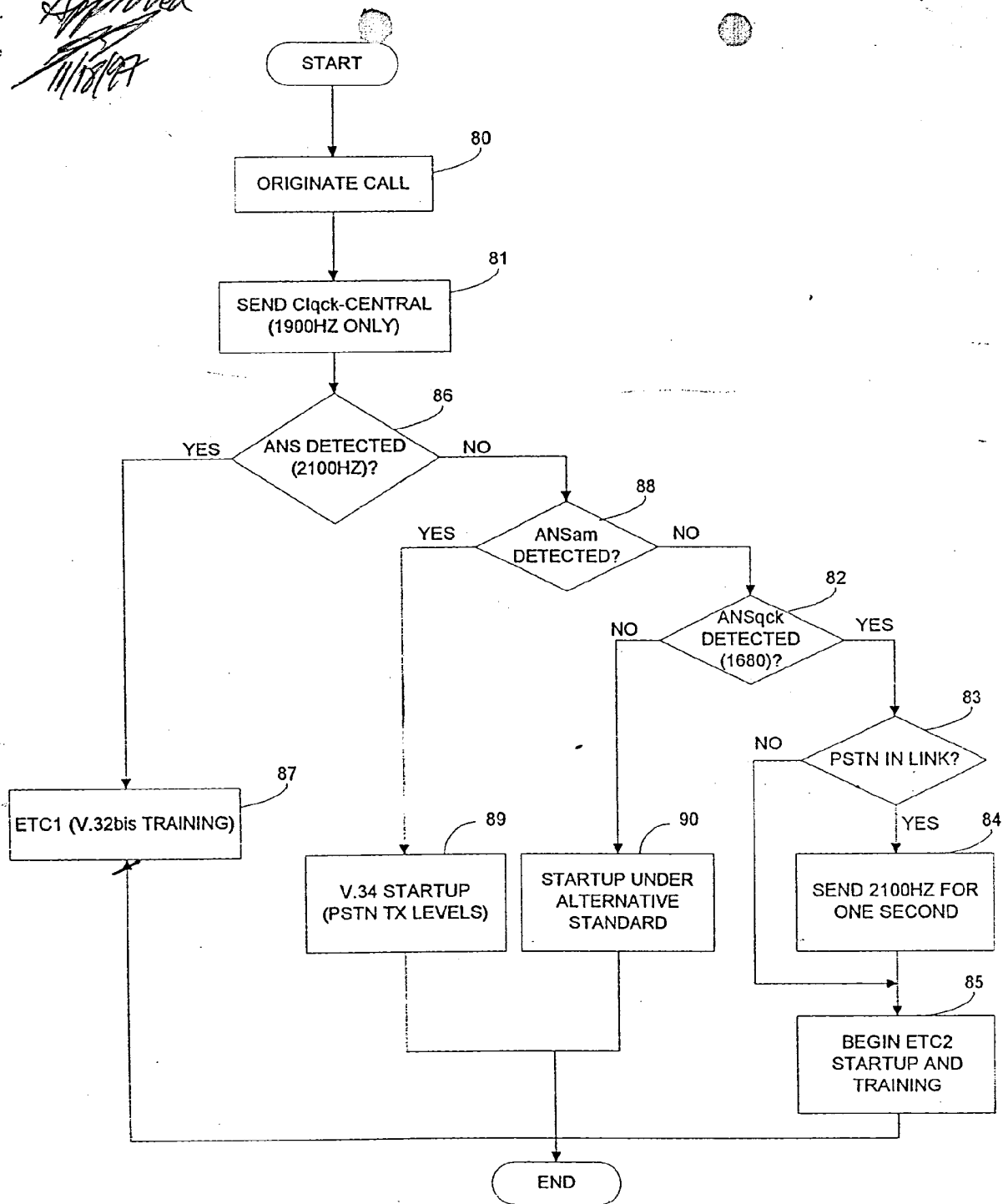
Respectfully submitted by,


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Registration No. 34,183

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(770) 933-9500

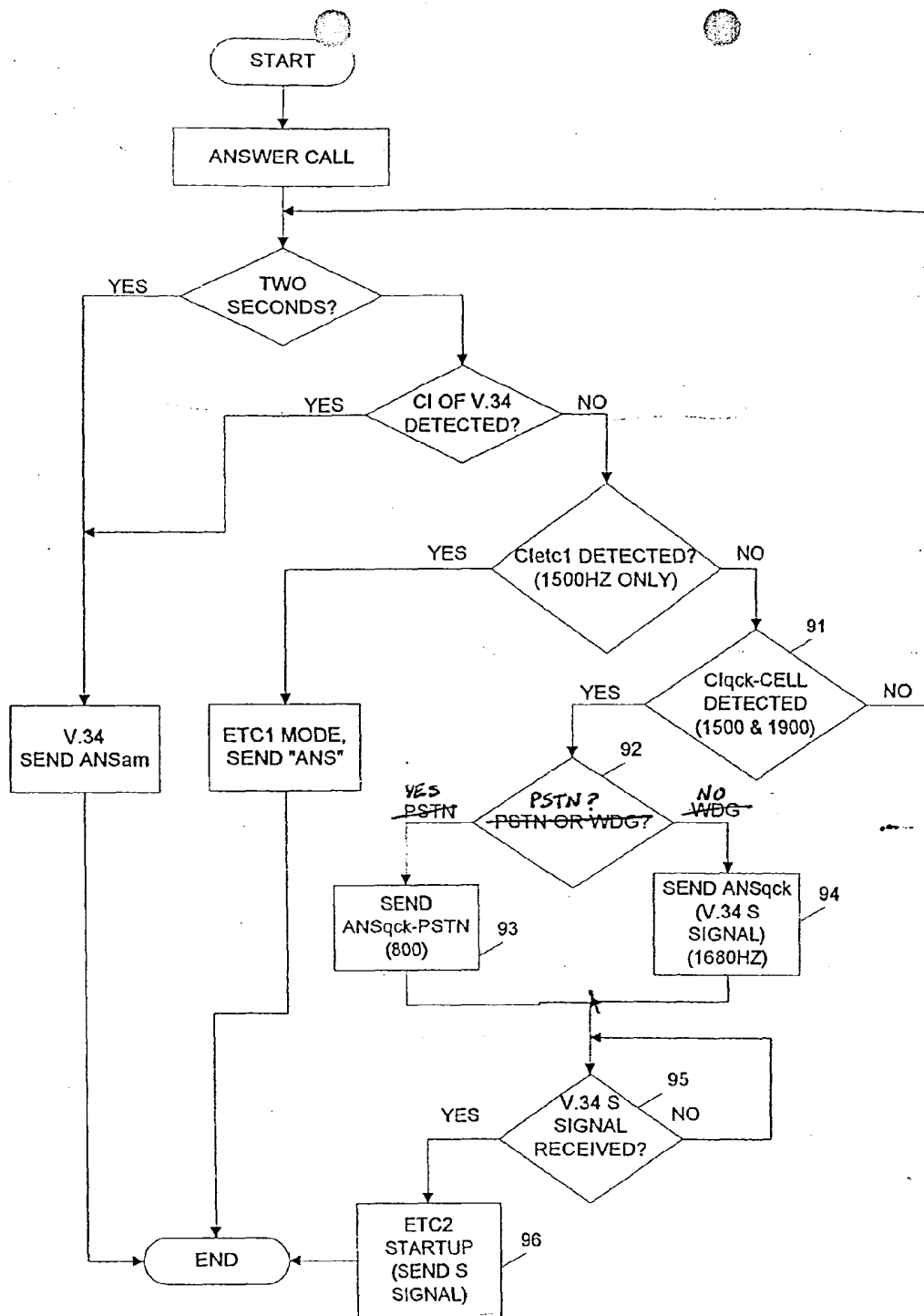
Docket No.: 061605-0590

Approved
11/18/97



Calling Modem -- Central Site
FIG. 6





Answer Modem -- Central Site
FIG. 7



GP-2614

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
In re application of:

Robert Scott

Docket No.: 061605-0590

Serial No.: 08/780,762

Examiner: J. Gluck

Filed January 8, 1997

Art Unit: 2614

For: PRESETTING LINK LAYER PARAMETERS
PER PHYSICAL LAYER START-UP

TRANSMITTAL LETTER FOR AMENDMENT

The Commissioner of Patents and Trademarks
Box Amendments
Washington, D.C. 20231

Atlanta, GA

October 23, 1997

Sir:

Transmitted herewith is/are the following in the above-identified application:

- | | |
|--|--|
| <input checked="" type="checkbox"/> Response/Amendment | <input checked="" type="checkbox"/> Return Postcard |
| <input type="checkbox"/> Fee as calculated below | <input type="checkbox"/> Supplemental Declaration |
| <input checked="" type="checkbox"/> No Additional Fee Required | <input type="checkbox"/> Check in the Amount of \$ _____ |
| <input checked="" type="checkbox"/> Corrected Drawings | <input type="checkbox"/> Terminal Disclaimer |

CLAIMS AS AMENDED BY A LARGE ENTITY						
Claims Remaining After Amendment		Highest Number Previously Paid For		Present Extra	Rate	Additional Fees
Total Claims	10	Minus	20	0	x \$22.00	\$ -0-
Independent Claims	3	Minus	3	0	x \$82.00	\$ -0-
[] First Presentation of A Multiple Dependent Claim					+ \$270	\$ -0-
EXTENSION FEE	1 st Month \$110 []	2 nd Month \$400 []	3 rd Month \$950 []	4 th Month \$1,510 []		\$ -0-
TOTAL ADDITIONAL FEE FOR THIS AMENDMENT						\$ -0-

- [] The Commissioner is authorized to charge Paradyne Corporation's Deposit Account No. 16-0255 in the amount of \$ _____ to cover the above listed additional fees.
- [X] In the event of non-payment or improper payment of a required fee, the Commissioner is authorized to charge or to credit Paradyne Corporation's Deposit Account No. 16-0255 as required to correct the error. A duplicate copy of this transmittal is enclosed.

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& RISLEY, L.L.P.
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Respectfully submitted,

Scott A. Horstemeyer
Registration Number 34,183

Certificate of Mailing

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope, with sufficient postage, addressed to: Assistant Commissioner for Patents, Box Amendments, Washington, D.C. 20231 on

OCT 23 1997

Signature:

REM 0056900

Exhibit 19

IEEE Std 100-1996

The IEEE Standard Dictionary of Electrical and Electronics Terms

Sixth Edition

**Standards Coordinating Committee 10, Terms and Definitions
Jane Radatz, Chair**

This standard is one of a number of information technology dictionaries being developed by standards organizations accredited by the American National Standards Institute. This dictionary was developed under the sponsorship of voluntary standards organizations, using a consensus-based process.

ISBN 1-55937-833-6



linkage

(11) The transmission path between any two interfaces of generic cabling. (C/LM) 802.3u-1995
(12) See also: directory entry. (C/PA) 1003.1b-1993s, 1003.2-1992s, 1003.5-1992, 1003.5b-1995

(13) See also: link, connector. (PE/T&D) 524-1992

linkage (1) (programming) Coding that connects two separately coded routines. (C) [85]

(2) (software) See also: link. (C) 610.12-1990

linkage editor (software) A computer program that creates a single load module from two or more independently translated object modules or load modules by resolving cross-references among the modules and, possibly, by relocating elements. May be part of a loader. *Synonym:* linker. See also: linking loader. (C) 610.12-1990

linkage product A device that provides an interface between network segments such as gateways or bridges. (C) 610.7-1995

linkage voltage test, direct-current test (rotating machinery)

A series of current measurements, made at increasing direct voltages, applied at successive intervals, and maintained for designated periods of time. *Note:* This may be a controlled overvoltage test. See also: asynchronous machine. (PE) [9]

link-attached terminal A terminal that is connected to the computer by telecommunication lines or by a data link. *Contrast:* channel-attached terminal. (C) 610.10-1994

link-break cutoff A load-break fuse cutoff that is operated by breaking the fuse link to interrupt the load current. (PE/SWG) C37.100-1992, C37.40-1993

link cable The physical medium connecting two link interfaces, comprising of two or more electrical or optical cables. (BA/C) 1355-1995

Link Code Word The 16 bits of data encoded into a Fast Link Pulse Burst. (C/LM) 802.3u-1995

link communication A physical means of connecting one location to another for the purpose of transmitting and receiving information. (C) 610.7-1995

link character (L_char) Control characters which are used on a link in order to ensure flow control and the proper functioning of the link. See also: normal character. (BA/C) 1355-1995

link, connector A rigid link designed to connect pulling lines and conductors together in series. It will not spin and relieve torsional forces. *Synonyms:* bullet; connector; link; slug. (PE/T&D) 524-1992

link count The number of directory entries that refer to a particular file. (C/PA) 1003.5-1992, 1003.5b-1995, 9945-1-1996, 9945-2-1993

linked linear list A linear list in which each item contains a pointer to the next item in the list, making it unnecessary for the items to be physically sequential. *Note:* the items are still logically adjacent. *Synonym:* linear linked list. (C) 610.5-1990

linked list (1) A list in which each item contains a pointer to the next or preceding item in the list, making it unnecessary for the items to be physically sequential. *Note:* Unless the list is circular, the last item in the list contains a null link field. *Synonyms:* chain; singly linked list. See also: chained list; circularly-linked list; linked linear list. (C) 610.5-1990

(2) (software) See also: chained list. (C/SE) 729-1983s

Linked List A software data structure composed of individually allocated memory objects, in which each item points to the next. It is used as a FIFO queue in this document. (C/MM) 1212.1-1993

linker See: linkage editor.

link error counter (LEC) A counter maintained by a network station to track all data link errors. The maximum permissible value is a system parameter. (EMB) 1073.3.1-1994

590

lip microphone

link field (A) A field in each item of a linked list, containing a pointer to the next or preceding item in the list. *Synonym:* chain field. (B) In a tree, that portion of each node that contains a pointer to other nodes in the tree. (C) 610.5-1990

linking loader A computer program that reads one or more object modules into main memory in preparation for execution, creates a single load module by resolving cross-references among the separate modules, and, in some cases, adjusts the addresses to reflect the storage locations into which the code has been loaded. See also: absolute loader; linkage editor; relocating loader. (C) 610.12-1990

link input A connection point for receiving signals. See also: link interface. (BA/C) 1355-1995

link interface (port) A connection point comprising a link input and a link output and implementing one of the relevant conformance subsets defined in IEEE Std 1355-1995. See also: link. (BA/C) 1355-1995

link is clear A condition in which there is no incoming energy on the link. See also: clear. (C/LM) 802.12-1995

link layer (LINK) (1) (Layer 2) The layer of the ISO Reference Model that provides the functional and procedural means to transfer data between stations, and to detect and correct errors that can occur in the Physical layer. (C/DIS) 1278.2-1995

(2) The layer, in a stack of three protocol layers defined for the Serial Bus, that provides the service to the transaction layer of one-way data transfer with confirmation of reception. The link layer also provides addressing, data checking, and data framing. The link layer also provides an isochronous data transfer service directly to the application. See figure 34 for the relation of the link layer to the Serial Bus protocol stack. (C/MM) 1394-1995

link output A connection point for transmitting signals. See also: link interface. (BA/C) 1355-1995

link pair A pair of links going in opposite directions between two stations. (C/LM) 802.5c-1991

link partner The device at the opposite end of a link segment from the local station. The link partner device may be either a DTE or a repeater. (C/LM) 802.3u-1995

link protocol In OSI, a protocol that ensures that the transmission of bits received are the same as the bits sent. (C) 610.7-1995

link pulse Communication mechanism used in 10BASE-T and 100BASE-T networks to indicate link status and (in Auto-Negotiation-equipped devices) to communicate information about abilities and negotiate communication methods. 10BASE-T uses Normal Link Pulses (NLPs), which indicate link status only. 10BASE-T and 100BASE-T nodes equipped with Auto-Negotiation exchange information using a Fast Link Pulse (FLP) mechanism that is compatible with NLP. (C/LM) 802.3u-1995

link segment (1) The physical interconnection between two repeaters or between a repeater and an end node. A link segment includes the link medium (twisted pairs or optical fibres) and its two attached Medium Dependent Interface (MDI) connectors. (C/LM) 802.12-1995

(2) The point-to-point full-duplex medium connection between two and only two MDIs. (C/LM) 802.3u-1995

Link Segment Delay Value (LSDV) A number associated with a given segment that represents the delay on that segment used to assess path delays for 100Mb/s CSMA/CD networks. LSDV is similar to SDV; however, LSDV values do not include the delays associated with attached end stations and/or repeaters. (C/LM) 802.3u-1995

link, swivel See: swivel link.

lin-log receiver A receiver having a linear amplitude response for small-amplitude signals and a logarithmic response for large-amplitude signals. (AE) 686-1990w

lip See: hook, conductor lifting.

lip microphone A microphone adapted for use in contact with the lip. See also: microphone. (EEC/PE) [119]

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Exhibit 20

Performance Analysis of CDMA_ALOHA/FEC Scheme in the Centralized Packet Radio Networks

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Abstract

In this paper, we analyze the performance of a CDMA_ALOHA scheme by considering the packet collision probability as well as the bit error probability. And we propose a new CDMA_ALOHA/FEC scheme which uses a block FEC code in the data link layer for correcting bit errors of the received packets. By analyzing the proposed scheme, we show that the system throughput closely relates to the bit error rates. The results also show that the system throughput can be significantly improved by using the FEC coding, approaching to the value which is competitive with the error-free channel.

1. Introduction

In recent years, there has been increased demands for mobile/personal communications services through wireless data networks. However, due to limited radio resources, only a finite number of mobile users can access the radio communication channels. Multiple access control protocols must be implemented to efficiently utilize the radio resources among all the users, and there has been increased interest and development in the multiple access protocols[1,2]. In particular, CDMA techniques are increasingly being used or considered for commercial applications, and are being developed as potential candidates in digital cellular mobile radio[2,3]

The MAC (Medium Access Control) protocol has a primary effect in the throughput and the delay performance

of the wireless networks. Among a lot of MAC protocols, ALOHA schemes, having a distinguished advantage of simplicity, experience the rapid decreases of performance under heavy traffic conditions due to collisions[10]. On the other hand, many researchers have been already devoted for applying either slotted or unslotted ALOHA protocols to the CDMA systems. And they have been shown that CDMA_ALOHA techniques have an improved performance[5,7,8].

The bit error probability due to multiple access interference has a significant influence in the QoS and the system performance[3,4]. In this paper, we analyze the CDMA_ALOHA scheme by considering the packet collision probabilities of the MAC layer as well as the BER of the physical layer. And we propose a new CDMA_ALOHA/FEC scheme which uses a block FEC code in the data link control layer for improving the system performances. The numerical results show that the system throughput is significantly improved by using a block FEC code, approaching to value which is competitive with the error-free channels.

This paper is organized as follows. Section 2 describes the system model and proposes CDMA_ALOHA/FEC scheme. In Section 3, we analyze the system performance of the proposed scheme. Section 4 discusses the numerical results and conclusions are given in Section 5.

2. System Descriptions

As depicted in figure 1, it is assumed that the system

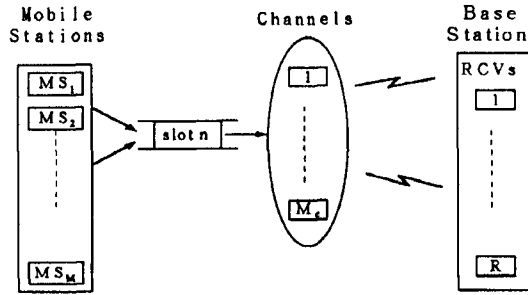


Figure 1. Wireless communication systems

consists of a base station and M mobile stations. There are R receivers in the base station. For simplicity, we only focus on a single-cell system. Multiple channels are provided by M_c spreading codes which are orthogonal to each other. All the mobile users share the M_c spreading codes.

Basically, a CDMA_ALOHA/FEC scheme operates in a slotted ALOHA mode in the MAC layer and corrects bit errors by using a FEC code in the DLC layer. When a user wishes to transmit a packet, he randomly chooses one of the spreading codes $\{c_i, i=1, \dots, M_c\}$, spreads and transmits in the next slot.

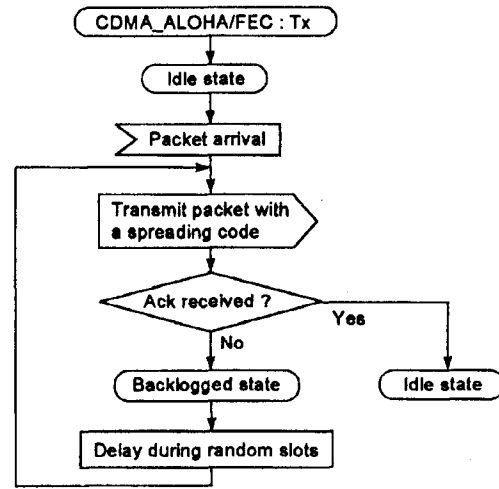
In this scheme, users suffer failures from transmission of a packet in the following reasons :

- i) packet collision occurs, that is, at least two users select one particular spreading code,
- ii) the received packet has errors that cannot be corrected with the FEC code, and
- iii) all receivers in the base station are busy.

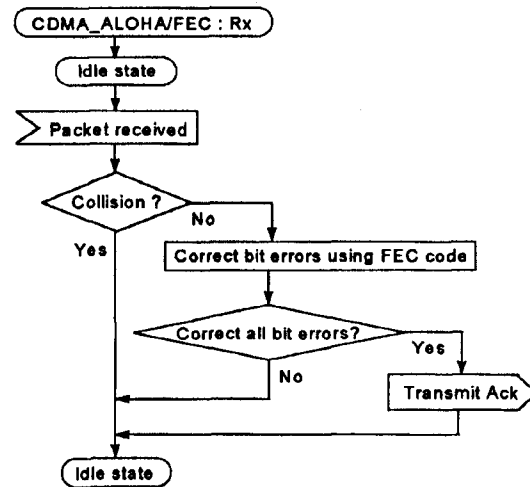
Users which fail to transmit enter into the backlogged state and retransmit its packet after a random delay. The detailed descriptions of the CDMA_ALOHA/FEC scheme are shown in figure 2.

3. Performance Analysis

In this section, we analyze the system throughput of CDMA_ALOHA/FEC scheme using a markov model. It is assumed that the user will generate a new packet in the following slot with the probability λ . If a user fails to transmit its packet due to the reasons described in the above section, we assume that it enters into a backlogged state and retransmits its packet in the next slot with the



(a) Mobile station's operation



(b) Base station's operation

Figure 2. Operations of CDMA_ALOHA/FEC

probability P_r . If we let the system state $x(t)$ be the number of backlogged users at the beginning of slot t , it can be easily shown that $\{x(t)\}$ is a finite state markov chain. The state transition probability P_{jk} , which is derived from probabilities that n_b packets from the backlogged state retransmit and n_i users (out of $M-j$) generate a new packet and s packets (out of n_b+n_i) are successfully transmitted, is given by

$$P_{jk} = \sum_{n_b=0}^j \sum_{n_i=0}^{M-j} \left\{ \frac{B(j, n_b, P_r) \times B(M-j, n_i, \lambda) \times S_s | n_b+n_i, M_c, R}{S_s | n_b+n_i, M_c, R} \right\} \quad (1)$$

where $s=j+n-k$, $0 \leq s \leq \min\{M_c, R, n_s+n_i\}$, and

$$B(n, i, p) = \binom{n}{i} p^i (1-p)^{n-i}.$$

The term $S_{s|n_s+n_i, M_c, R}$ is the conditional probability that s packets (out of n_s+n_i) are successfully transmitted with M_c channels and R receivers available.

By conditioning on the number of packets simultaneously transmitted over the arbitrary first channel and using the total probability, we have

$$S_{s|n, M_c, R} = \sum_{i=0}^n B\left(n, i, \frac{1}{M_c}\right) \times P(s|i, M_c, R) \quad (2)$$

where i is the number of packets transmitted over the first channel, and $B\left(n, i, \frac{1}{M_c}\right)$ is the probability that i packets

(out of n) are transmitted over the first channel. The term $P(s|i, M_c, R)$ is the probability that i packets (out of n) select the first channel, and then s packets (out of i) succeed to transmit with the M_c channels and R receivers. The term $P(s|i, M_c, R)$ can be recursively derived by

$$P(s|i, M_c, R) = \begin{cases} S_{s|n, M_c-1, R} & , \text{ for } i=0 \\ P_s(n) S_{s-1|i-1, M_c-1, R-1} + \\ (1-P_s(n)) S_{s|i-1, M_c-1, R-1} & , \text{ for } i=1 \\ P_s(n) P_c(i) S_{s-1|i-1, M_c-1, R-1} + \\ \{1-P_s(n) P_c(i)\} S_{s|i-1, M_c-1, R-1} & , \text{ for } 2 \leq i \leq n \end{cases} \quad (3)$$

where $P_s(n)$ is the probability that all the bit errors in a received packet are corrected by using the FEC codes, and $P_c(i)$ is the probability that one out of i simultaneous packets is successfully captured by the receiver.

In (3), the term for $i=0$ is the probability that s packets must be successfully transmitted over the remaining channels because any packet does not select the first channel. The second term, for $i=1$, is the probability that $s-1$ packets (out of $n-1$) are successfully transmitted over the remaining channels in the case of having no packet errors. The third term is the probability that $s-1$ packets (out of $n-i$) are successfully transmitted over the remaining M_c-1 channels in the case of not only being captured by the receiver but also having no packet error.

The initial conditions for $S_{s|n, M_c, R}$ are given by

$$\begin{aligned} & \text{for } M_c \geq 0 \text{ and } R \geq 0, S_{0|0, M_c, R} = 1, S_{1|0, M_c, R} = 0 \\ & \text{for } n \geq 0 \text{ and } R \geq 0, S_{0|n, 0, R} = 1, S_{1|n, 0, R} = 0 \\ & \text{for } M_c \geq 1 \text{ and } R \geq 1, S_{0|1, M_c, R} = 1 - P_s(1), \\ & S_{1|1, M_c, R} = P_s(1) \\ & \text{for } n \geq 2 \text{ and } R \geq 1, S_{1|n, 1, R} = P_s(n) \cdot P_c(n), \\ & S_{0|n, 1, R} = 1 - P_s(n) \cdot P_c(n) \\ & \text{for } s > \min\{n, M_c, R\}, S_{s|n, M_c, R} = 0 \end{aligned} \quad (4)$$

The probability $P_c(i)$ is given by

$$P_c(i) = \begin{cases} 1 & , \text{ for } i = 1 \\ Q^i & , \text{ for } i \geq 2 \\ 0 & , \text{ otherwise} \end{cases} \quad (5)$$

where i is the number of packets to be transmitted simultaneously over the same channel, and Q is the capture ratio[6].

By using the BER model in [4], we have the packet success probability $P_s(n)$ as

$$P_s(n) = \sum_{i=0}^L \binom{L}{i} P_e^i(n) (1 - P_e(n))^{L-i} \quad (6)$$

where L is the packet length, i is the maximum number of bits to be corrected, and $P_e(n)$ is the bit error probability in the environment of n multiple access interference as presented in [4].

$$P_e(n) = Q \left[\left[\frac{n-1}{3N} + \frac{N_0}{2E_b} \right]^{-1/2} \right] \quad (7)$$

where, $Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^\infty e^{-u^2/2} du$, and N is the processing gains. The FEC coding rate r is defined as $r=k/L$ where L is the packet length and k is the number of information bits.

Once the probability P_s is obtained, we can derive the probability π_i [9] that the system is in state i , and the system throughput S that is the average number of new packets generated during one slot time. The system throughput is given by

$$S = \lambda \left(M - \sum_{i=0}^M i \pi_i \right) \quad (8)$$

where $\pi_i = \sum_{j=0}^M \pi_j P_{ji}$, and $\sum_{i=0}^M \pi_i = 1$

4. Numerical Results

In this section, we present some numerical results for the system throughput of the proposed scheme. At first, we illustrate how the performance of CDMA_ALOHA/ FEC scheme will be affected by the BER due to the multiple access interference. In this analysis, we assume that $M_c=3$, $R=3$, and $P_r=0.1$. Figure 3 shows the throughput comparison between the error free ideal channel environment (a) and the erroneous channel one without the FEC coding (b). For simplicity, the capture capability is not considered in this figure (i.e. $Q=0.0$). Since the multiple access interference will increase along with the increase of the offered traffic load, the BER in the received packets will also increase, and inversely the packet success probability $P_s(n)$ will decrease. So the erroneous channels result in lower system throughput than the ideal channel conditions. By comparing figure 3(b) with figure 4 (FEC coding rate $r=1.0$), we manifest that the capture capabilities of the CDMA system improve the system throughput.

Figure 4 and 5 show the performance improvement through the FEC coding in the DLC layer. We assume that $M=20$, $L=100$ bits, $M_c=3$, $R=3$, $Q=0.9$. And for the $P_s(n)$ in the physical layer, $E_b/N_0=6$ dB, and the processing gain $N=16$ dB is assumed. When the FEC coding rate r decreases to 0.9, the system throughput increases about 40 percent as compared with $r=1.0$. And when $r=0.8$, the increase in the system throughput approaches to about 48

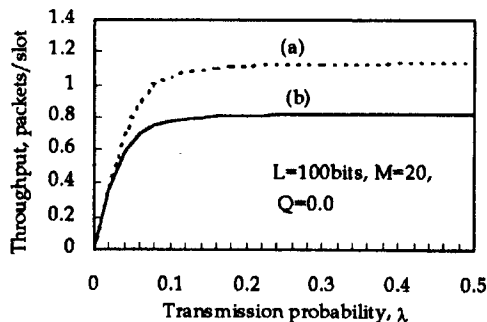


Figure 3. Through comparison between the error-free channel and the erroneous channel : (a) error free channel, (b) erroneous channel ($E_b/N_0=6$ dB, $N=20$ dB, $r=1.0$)

percent. As illustrated in the figure 4, if we enlarge the FEC code length for correcting more bit errors, the overall system throughput might be increased. But the user throughput, which is the throughput of the user data, is decreased as shown in figure 5 due to the packet overhead by the FEC codes.

In figure 6, we show how the FEC coding influences the system performance under the two different kind of processing gains ($N=16$ dB, $N=10$ dB). In general, the BER of the CDMA systems with the low processing gain increases more than the higher one. So, it results in the degradation of the system throughput. When $N=16$ dB and $r=0.8$, the system performance is improved about 48 percent as compared with the no FEC coding. But in the case of $N=10$ dB, there is about 110 percent increases in the throughput. So, from figure 6, we notice that the FEC coding in the data link control layer might be necessary for improving the system throughput, especially in the lower processing gain systems.

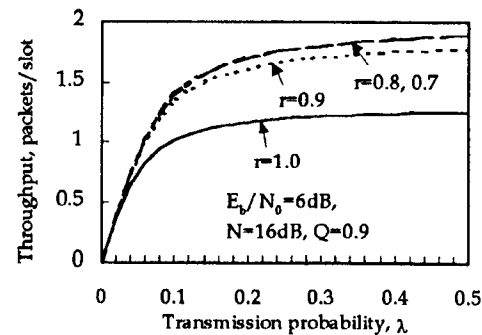


Figure 4. System throughput according to the FEC coding rates

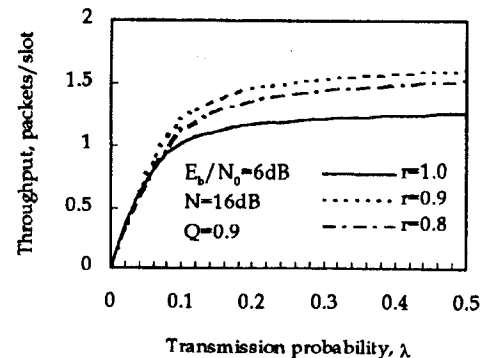


Figure 5. User Throughput

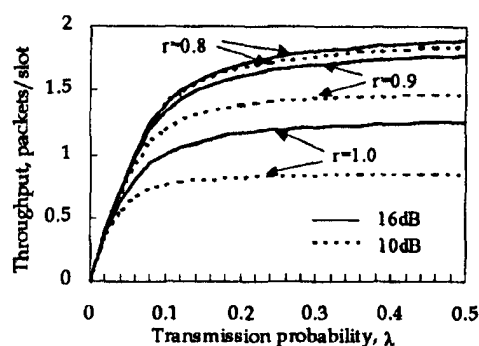


Figure 6. System throughput according to the processing gain

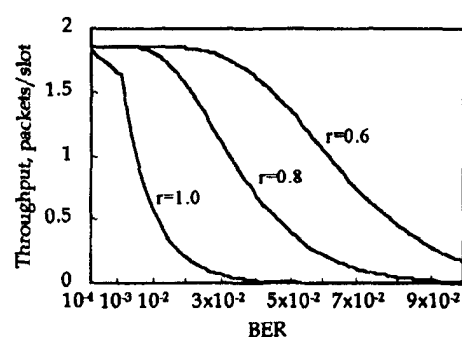


Figure 7. System throughput vs. BER
($\lambda=0.394$, $Q=0.9$)

The maximum achievable throughput and the optimum FEC coding rates in the various BER condition are depicted in figure 7. The retransmission scheme may be sufficient to achieve the maximum throughput under the bit error conditions of lower than 10^{-4} . But as expected, this figure notices that the FEC scheme at the DLC layer is necessary to improve the throughput as the BER increases.

5. Conclusions

We have proposed and analyzed a CDMA_ALOHA/FEC scheme to address the medium access control and the data link control for the centralized packet radio networks. In this scheme, a slotted ALOHA protocol is used as the medium access control, and the multiple channels are provided by the spreading codes. For the purpose of further reducing the packet error rates, we adapted the FEC scheme in the data link control layer.

It is observed that the BER by the multiple access interference affects the system performance. We also investigated that the FEC scheme at the data link control layer improves the throughput performance greatly.

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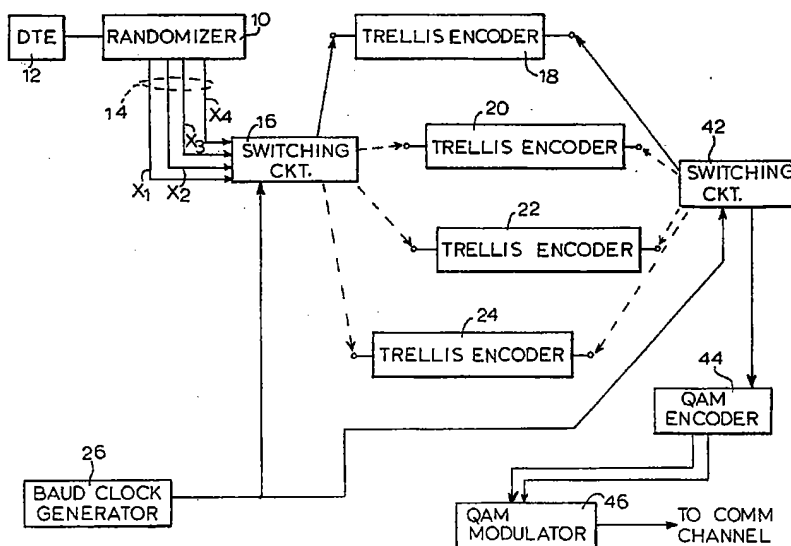
Exhibit 21

United States Patent [19]

Betts et al.

[11] Patent Number: **4,677,625**[45] Date of Patent: **Jun. 30, 1987**[54] **DISTRIBUTED TRELLIS ENCODER**[75] Inventors: **William L. Betts, St. Petersburg;
Kenneth Martinez, Pinellas Park;
Gordon Bremer, Clearwater, all of
Fla.**[73] Assignee: **Paradyne Corporation, Largo, Fla.**[21] Appl. No.: **707,084**[22] Filed: **Mar. 1, 1985**[51] Int. Cl.⁴ **G06F 11/10; H03M 13/22**[52] U.S. Cl. **371/43; 340/347 DD;
371/2; 375/26; 375/39**[58] Field of Search **340/347 DD; 371/43-45,
371/2; 360/39-42; 375/25, 34, 39**[56] **References Cited****U.S. PATENT DOCUMENTS**4,087,787 5/1978 Acampora 371/43
4,240,156 12/1980 Doland 371/434,500,994 2/1985 McCallister et al. 371/43
4,536,878 8/1985 Rattlingourd et al. 371/43*Primary Examiner—T. J. Sloyan
Attorney, Agent, or Firm—Kane, Dalsimer, Sullivan,
Kurucz*[57] **ABSTRACT**

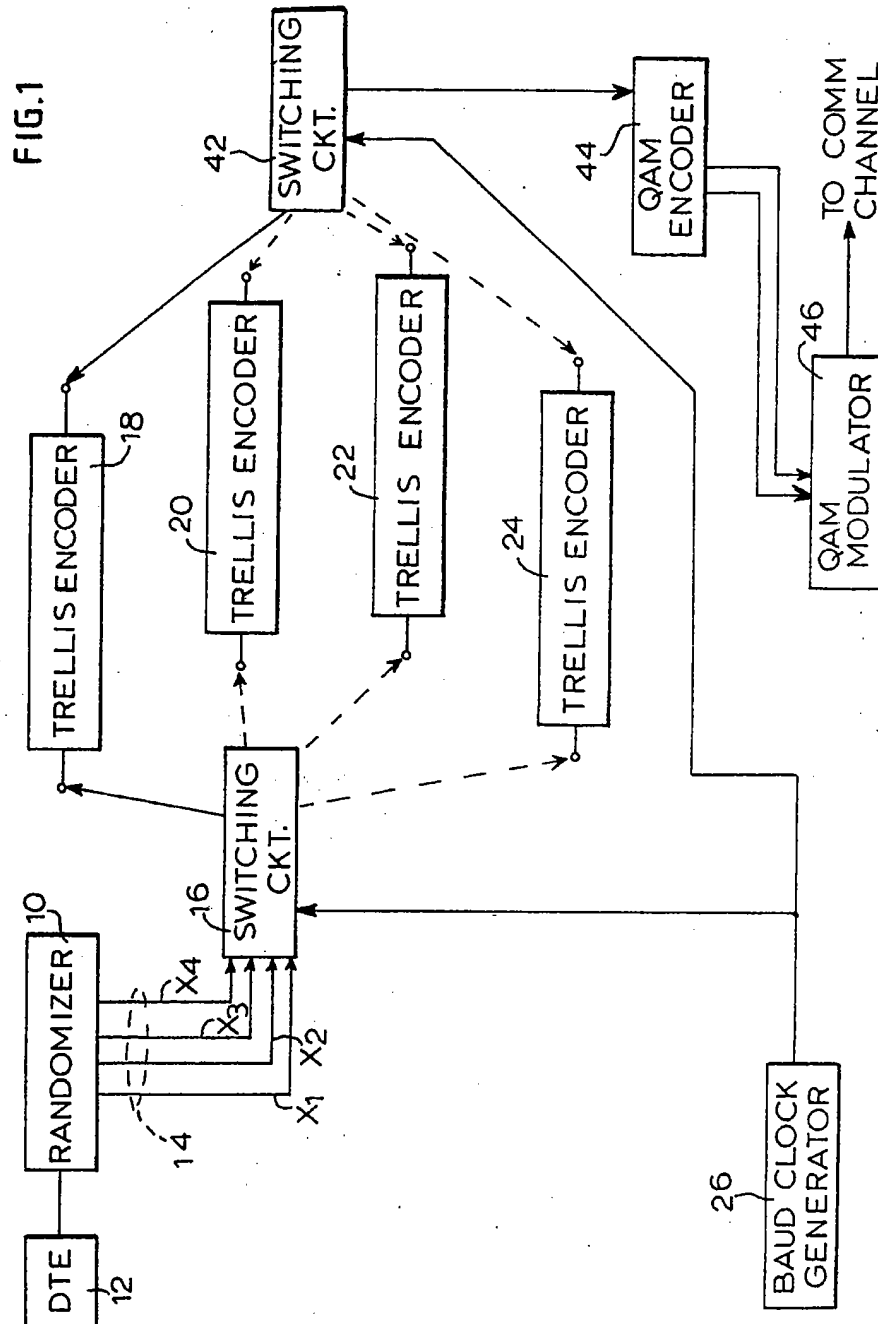
In the transmitter of a data communication system using QAM, a plurality of trellis coders with delay units are used for forward error correction. The output of each encoder is modulated using QAM to generate sequential baud signal elements. The redundant data bits generated are distributed between several non-consecutive bauds. Likewise, at the receiver a plurality of distributed convolutional decoders are utilized to decode the received signal element. The distributed trellis decoder is self-synchronizing.

11 Claims, 4 Drawing Figures

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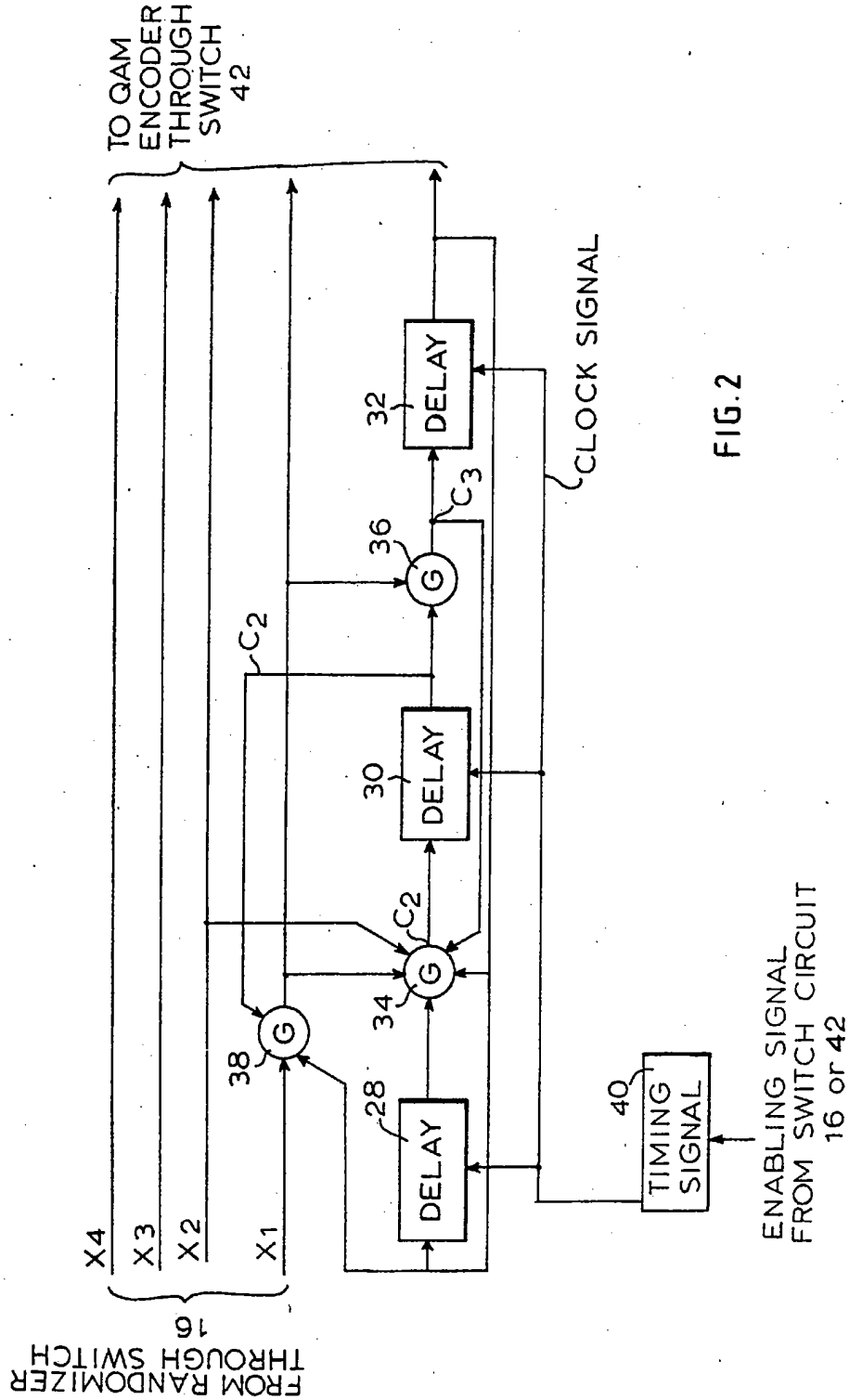
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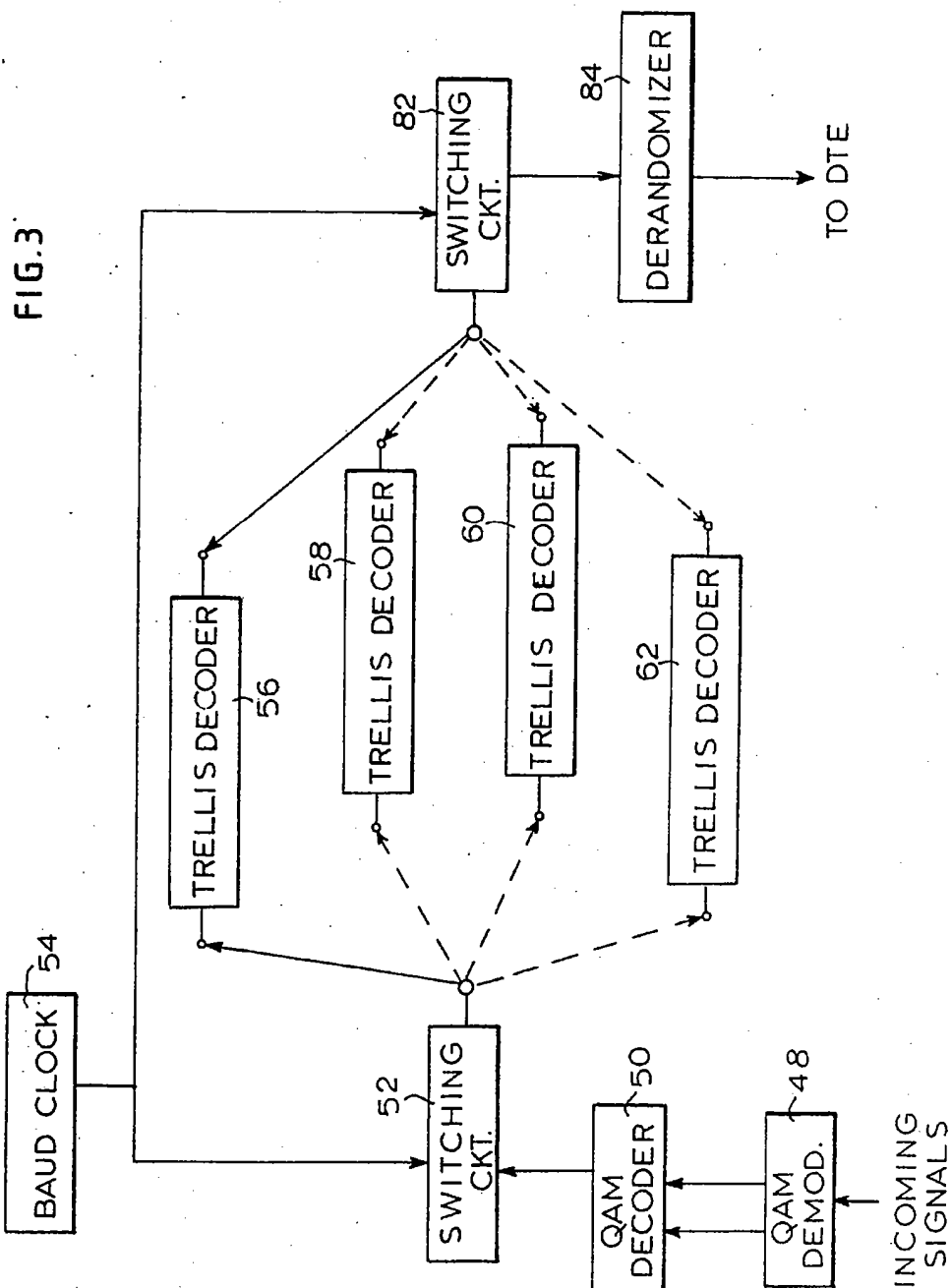
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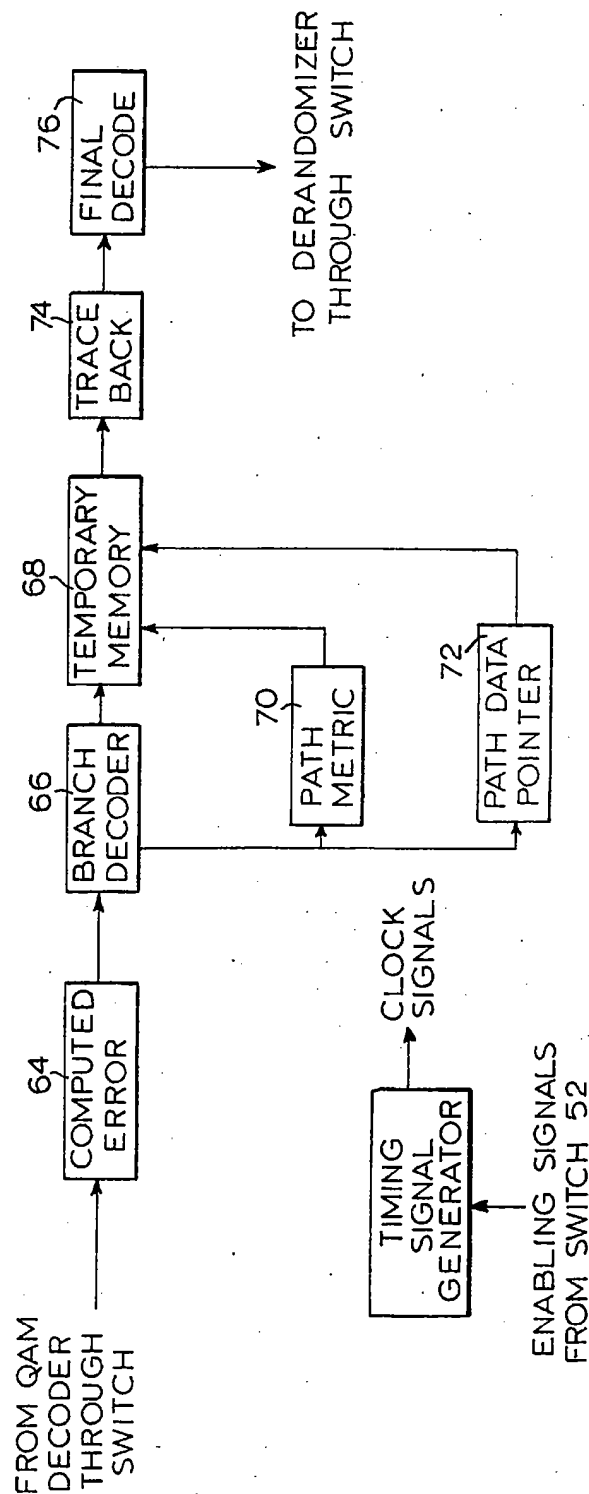


FIG. 4

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DISTRIBUTED TRELIS ENCODER**RELATED APPLICATIONS**

The subject matter of this application is related to U.S. applications Ser. No. 707,085 entitled Self-Synchronizing Interleaver for Trellis Encoder used in Wireline Modems and Ser. No. 707,083 entitled Self-Synchronizing De-Interleaver for Viterbi Decoder Used in Wireline Modems, filed on even date herewith and incorporated herein by reference.

BACKGROUND OF THE INVENTION**1. Field of Invention**

This invention pertains to an apparatus and method of encoding binary bits and more particularly to a method and apparatus for making use of a forward error correction scheme for a reduced number of errors at a given signal-to-noise ratio.

2. Description of the Prior Art

Communication networks using high speed data rates require high signal-to-noise ratios for proper data transmission. Numerous schemes and combinations thereof have been proposed to reduce the number of errors at these given signal-to-noise ratios. For example, in U.S. Pat. No. 4,077,021 to Csajka et al a forward error correcting scheme is described making use of the so-called Viterbi algorithm. In a further development described by the CCITT study group XVII, Contribution No. D180, in October, 1983, entitled TRELIS-CODED MODULATION SCHEME WITH 8-STATE SYSTEMATIC ENCODER AND 90 SYMMETRY FOR USE IN DATA MODEMS TRANSMITTING 3-7 BITS PER MODULATION INTERVAL a two-dimensional trellis for a quadrature amplitude modulation scheme is disclosed having 90° symmetry which results in a 4db gain in the signal-to-noise ratio. Typically, in forward error coding, redundant bits are added systematically to the data bits so that normally only predetermined transitions from one sequential group of bits (corresponding to bauds) to another are allowed. There is an inherent correlation between these redundant bits over consecutive bauds. At the receiver each baud is tentatively decoded and then analyzed based on past history, and the decoded bits are corrected if necessary. However, it was found that certain types of relatively long error signals, such as for example, low frequency phase jitter, cause a constant phase error in the signal constellation for extended (consecutive baud) periods of time. This type of error prevents or inhibits the correction of the received bits using the schemes described above.

OBJECTIVES AND SUMMARY OF THE INVENTION

A principal objective of the present invention is to provide a device and method for data communication in which the effects of long bursts of error signals such as low frequency phase jitter are minimized.

A further objective is to provide a method of adapting a standard modem to perform the subject method and to provide a method that is self-synchronizing.

Other objectives and advantages of the invention shall become apparent from the following description of the invention.

In the present invention the correlation of the redundant bits of different baud signals is distributed in time prior to encoding at the transmitter. A distributed trellis

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encoding scheme is used to obtain the redundant bits. At the receiver the received bauds are decoded using a plurality of distributed decoders which extract samples from multiple bauds for trellis decoding. The result is similar to that achieved by interleaving but avoids synchronization problems associated with the conventional complex interleaving processes.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 shows the elements of a data transmitter constructed in accordance with the invention;

FIG. 2 shows the elements of a distributed trellis encoder;

FIG. 3 shows the elements of a receiver for receiving data from the transmitter of FIG. 1; and

FIG. 4 shows the elements of a distributed trellis decoder.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIG. 1, a transmitter according to this invention comprises a randomizer 10 which receives serially a stream of data bits from DTE 12. The randomizer scrambles the bits in a preselected pattern and generates randomized bits on parallel output lines 14 identified as X1, X2, X3 and X4.

These output lines are fed by an electronic switching circuit 16 to a plurality of identical trellis encoders 18, 20, 22 and 24.

The electronic switching circuit 16 switches the signals from the randomizer 10 to one of the trellis encoders 18, 20, 22 and 24, in accordance with a baud clock signal generated by baud clock generator 26. In other words, for each baud period all the randomizer outputs X1, X2, X3 and X4 are fed to one of the encoders. Details of the trellis encoders 18, 20, 22 and 24 are shown in FIG. 2.

Each encoder comprises three delay units 28, 30 and 32 which are adapted to generate a delay of one baud period. The encoder further comprises three gates 34, 36 and 38. These gates may be for example XOR (exclusive -OR) gates.

The trellis encoder shown in FIG. 2 is well known in the art and need not be described any further. Preferably all the elements of the encoder are digital elements which are enabled by appropriate clocking signals from timing signal generator 40. The timing signal generator is enabled only when it receives an appropriate signal from switching circuit 16. Thus each encoder is active only when it is addressed by switching circuit 16. At all other times, the trellis encoders are idle.

Outputs Y0, Y1, X2, X3 and X4 are fed from the respective trellis encoders by a second electronic switching circuit 42 to QAM (quadrature amplitude modulation) encoder 44. Switching circuit 42 is also enabled by baud clock generator 26 so that it operates simultaneously with switching circuit 16. QAM encoder 44 selects a point of a preselected signal constellation corresponding to the inputs from circuit 42 and generates an in-phase and a quadrature output signal corresponding to said point. These output signals are fed to a QAM modulator 46 which generates corresponding analog QAM signals having a baud period equal to the period of the signals generated by signal generator 26. The signals from modulator 46 are transmitted over a common data communication channel to a receiver.

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In effect the bits of several consecutive signals are spaced out over several bauds by the distributed trellis encoders.

At the receiver, illustrated in FIG. 3, the incoming analog signals are demodulated by a QAM demodulator 48 which generates an in-phase and a quadrature signal which are fed to a QAM decoder 50. The QAM decoder 50 selects a point on the signal constellation closest to the actual point corresponding to the signals received from QAM demodulator 48. The bits corresponding to said point are sent to a third electronic switching circuit 52 having a period equal to the baud period of the received signals. Circuit 52 accesses sequentially one of four distributed trellis decoders 56, 58, 60 and 62 in response to the switching signal from generator 54. Thus all the binary signals from QAM decoder 50 corresponding to each received QAM signal are sent to one of the trellis decoders. The four trellis decoders are standard decoders well known in the art. One such decoder is shown in FIG. 4.

In a typical trellis decoder, the signals from the QAM decoder (in the present case, via switching circuit 52) are fed into an error computer circuit 64 which generates an error signal based on previously received signals. This error signal is fed to a branch decoder 66. The branch decoder uses the trellis branch rules (predetermined in accordance with the Viterbi algorithm) to generate a set of possible points corresponding to the received point. These set of points are stored in temporary memory 68. The decoder then searches through the points of the set to calculate the point with the smallest errors in accordance with appropriate constants stored in the path metric memory 70 and path pointer memory 72. The smallest error is used by trace back memory 74 to track back the last 4-16 bauds (in accordance with a preselected well-known scheme) to generate the final received point. The final received point of the set of points in memory 68 is fed to final decoder 76 as the received point.

As with the encoder of FIG. 2, each decoder comprises digital elements which are enabled by a timing signal generator 78.

The timing signal generator is enabled by an appropriate signal from switching circuit 52 only when the respective decoder is addressed by the switching circuit. Generator 78 generates clocking signals for the various decoder elements. Thus each decoder 56, 60 and 62 is active only when it is addressed by switching circuit 52, and otherwise it is idle.

The output of each decoder is accessed sequentially by a fourth electronic switching circuit 82 which is synchronized by the baud clock generator 54 so that it is in step with switching circuit 52. In other words, each trellis decoder is accessed simultaneously by switching circuits 52 and 82. The switching circuit 82 feeds the signals from the decoders to derandomizer 84 for reversing the effects of randomizer 10 and then to a user DTE.

It can be seen from the above description that switching circuits 16 and 52 acts as multiplexers while switching circuits 42 and 82 act as demultiplexers. The effect of this switching is to interleave the data bits at the transmitter across four bauds, and deinterleave these bits at the receiver. Obviously the trellis encoders are self-synchronized so that no synchronizing signals are needed between the transmitter and receiver.

In the above description consecutive bits are interleaved across four bauds by using four distributed trellis

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encoders and decoders. Obviously if more encoders and decoders are used the number of bauds over which interleaving occurs increases.

It should be appreciated that the invention makes use of standard QAM encoders, modulators, decoders, demodulators and standard trellis encoders and decoders which are well known in the art. Furthermore, while baud clock generators 26 and 54 are described as separate elements, in practice they can be incorporated in the QAM modulator and demodulator respectively. All the circuits of FIGS. 1 and 3 may be implemented by using a digital microprocessor.

Obviously, numerous modifications to the subject application may be made without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. A data transmission section for a modem coupled to a channel for sending data signals comprising:

1. A plurality of trellis encoders, each trellis encoder having an input for receiving n plain text bits, each encoder being provided to interleave bits received by the encoder during a first baud period with bits received during more than two previous baud periods to generate n trellis encoded bits, k , being larger than one; in a single baud period, each trellis encoder having means for delaying at least some of said n plain text bits so that they may be outputted and combined with bits outputted from one or more other trellis encoders during single baud periods;

2. encoder activating means for selectively activating only one of said trellis encoders for one baud period in a preselected sequence whereby bits received during a baud period i are interleaved with bits received during a baud period $i-k$;

3. signal encoding means for converting encoded bits into signals suitable for transmission over said channel; and

4. transmitter switching means for feeding n plain text bits per baud period to the activated trellis encoder and for sending the encoded bits from the activated trellis encoder to the signal encoding means.

2. A receiver section for a modem receiving data signals from a channel, said signals having been trellis encoded by interleaving bits corresponding to a baud period i with bits corresponding to a baud period $i-k$, k being larger than two, and having:

1. a demodulator and a decoder connected to the output of said demodulator for converting analog data signals from said channel into multiple series of bits, each series of bits substantially corresponding to a point of said analog data signal's preselected signal constellation;

2. k trellis decoders, each trellis decoder having an input from said decoder for receiving series of bits from said decoder and generating n bits of plain text bits corresponding to n bits received at least during two previous baud periods;

3. decoder activating means for activating only one of said trellis decoders during one baud period in another predetermined sequence; and

4. receiver switching means for feeding n encoded bits to the activated decoder and for collecting n plain text bits from the activated decoder.

3. A method of transmitting a plurality of input data bits over a channel by quadrature amplitude modulator comprising:

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- providing a plurality of trellis encoders, each encoder using an identical scheme to interleave bits received during a first baud period with bits received during more than two earlier baud periods preceding said first baud period to generate output bits; 5 activating each of said trellis encoders in a preselected order for a baud period; feeding bits which occur during a single baud period to only one of said plurality of trellis encoders; 10 delaying at least some of said bits in said one trellis encoder during a single baud period; combining bits which have been outputted from said one trellis encoder with bits which have been outputted from one or more different trellis encoders for transmission during a single baud period; and 15 quadrature amplitude modulating output bits of each activated trellis encoder.
4. A system for transmitting data signals over a data channel comprising:
- a. a data transmission section coupled to said channel 20 for sending data signals and having:
1. A plurality of trellis encoders, each trellis encoder having an input for receiving n plain text bits each encoder being provided to combine bits received by the encoder during more than two 25 previous baud periods with bits received during a previous baud period to generate n trellis encoded bits in a single baud period, each trellis encoder having means for delaying at least some of said n plain text bits so that they can be outputted and combined with bits outputted from one or more other trellis encoders during single baud periods; 30
 2. encoder activating means for selectively activating only one of said trellis encoders for one baud period in a preselected sequence; 35
 3. signal encoding means for converting encoded bits into signals suitable for transmission over said channel; and
 4. transmitter switching means for feeding n plain 40 text bits per baud period to the activated trellis encoder and for sending the encoded bits from the activated trellis encoder to the signal encoding means; and
- b. a receiver section for receiving data signals from 45 said channel, and having:
1. a demodulator and a decoder connected to the output of said demodulator for converting ana-

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- log data signals from said channel into multiple series of bits, each series of bits substantially corresponding to a point of said analog data signal's preselected signal constellation of;
2. a plurality of trellis decoders equal in number to the trellis encoders, each decoder generating n bits of plain text bits corresponding to n bits received by the encoder during a baud period and n bits received at least during a previous baud period;
 3. decoder activating means for activating only one of said trellis decoders during one baud period in another predetermined sequence; and
 4. receiver switching means for feeding n bits to the activated decoder and for collecting n plain text bits from the activated decoder.
5. The system of claim 4 wherein said transmitter switching means comprises a first transmitter switch for providing input bits to the activated trellis encoder, and a second transmitter switch for providing encoded bits from the activated trellis encoder to the signal encoding means.
6. The system of claim 5 wherein said signal encoding means comprises a quadrature amplitude modulator.
7. The system of claim 6 wherein said signal decoding means comprises a quadrature amplitude demodulator.
8. The system of claim 7 wherein there are k trellis encoders each trellis encoders including several delay elements for combining the bits received during said one baud periods with bits received during several preceding baud periods each preceding baud period being separated from the next baud period by $(k-1)D$ seconds where D is the duration of a period.
9. The system of claim 7 wherein said receiver switching means comprises a first receiver switch for feeding encoded bits to the activated decoders and a second receiver switch for collecting plain text bits from the activated decoders.
10. The system of claim 7 wherein each period has a time duration of D seconds and each encoder includes a delay element for delaying bits received during a baud period by D seconds.
11. The method of claim 3 further comprising providing a plurality of trellis decoders for sequentially decoding transmitted signals, each trellis decoder being activated sequentially for a baud period for deinterleaving said signals.

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Exhibit 22



US005706312A

United States Patent [19]

Wei

[11] Patent Number: 5,706,312

[45] **Date of Patent:** Jan. 6, 1998

- [54] **TRELLIS CODED MODULATION
EMPLOYING LOWER DIMENSIONALITY
CONVOLUTIONAL ENCODER**

5,363,408	11/1994	Pair et al.	375/261
5,398,073	3/1995	Wei	348/487
5,442,626	8/1995	Wei	370/20

[75] Inventor: Lee-Fang Wei, Lincroft, N.J.

[73] Assignee: **Lucent Technologies Inc.**, Murray Hill, N.J.

[21] Appl. No.: 840,438

[22] Filed: Mar. 31, 1997

Related U.S. Application Data

- [63] Continuation of Ser. No. 321,363, Oct. 11, 1994, abandoned.
- [51] Int. Cl.⁶ H04L 5/12; H03M 13/12
- [52] U.S. Cl. 375/298; 375/265; 371/43
- [58] Field of Search 375/262, 264,
375/265, 286, 295, 298, 340-341; 371/37.5,
37.8, 43

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Primary Examiner—Young T. Tse
Attorney, Agent, or Firm—R. D. Slusky

[57] **ABSTRACT**

Coding gain is improved by employing an N -dimensional trellis encoder incorporating an N' -dimensional convolutional encoder where N' is less than N . The additional coding gain is realized as a shaping gain. This unique modulator encodes a digital signal by generating a sequence of N -dimensional symbols as a function of the digital signal using an N' -dimensional convolutional encoder within the trellis encoder more than once (integer N/N' times) during each N -dimensional symbol interval. This allows the trellis encoder to produce an output of higher dimensionality than would normally be expected from the lower dimensionality convolutional encoder. The trellis encoder is applicable to television transmission.

47 Claims, 6 Drawing Sheets

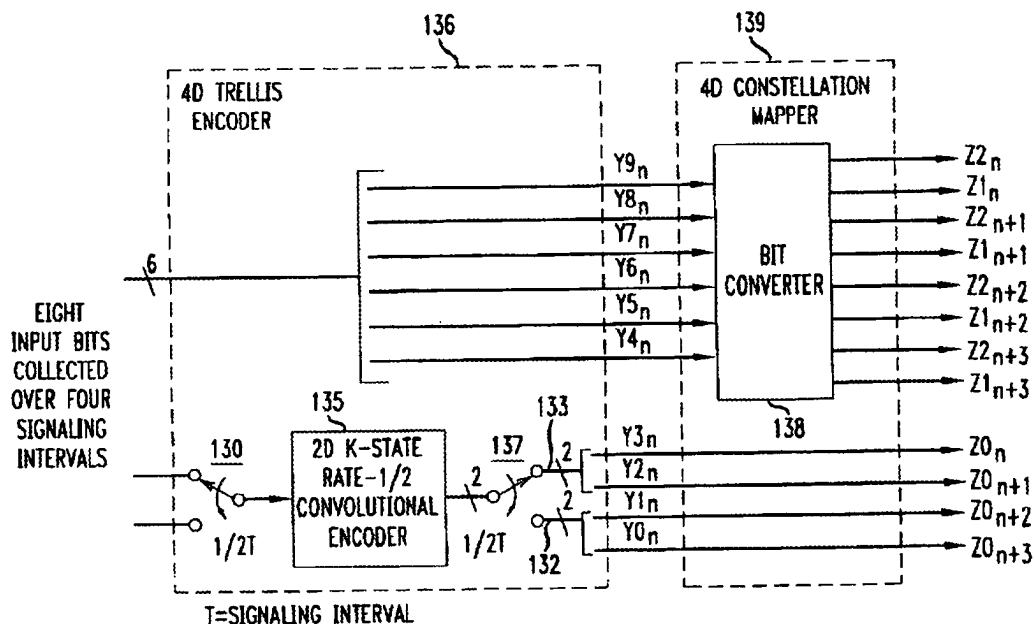


FIG. 1

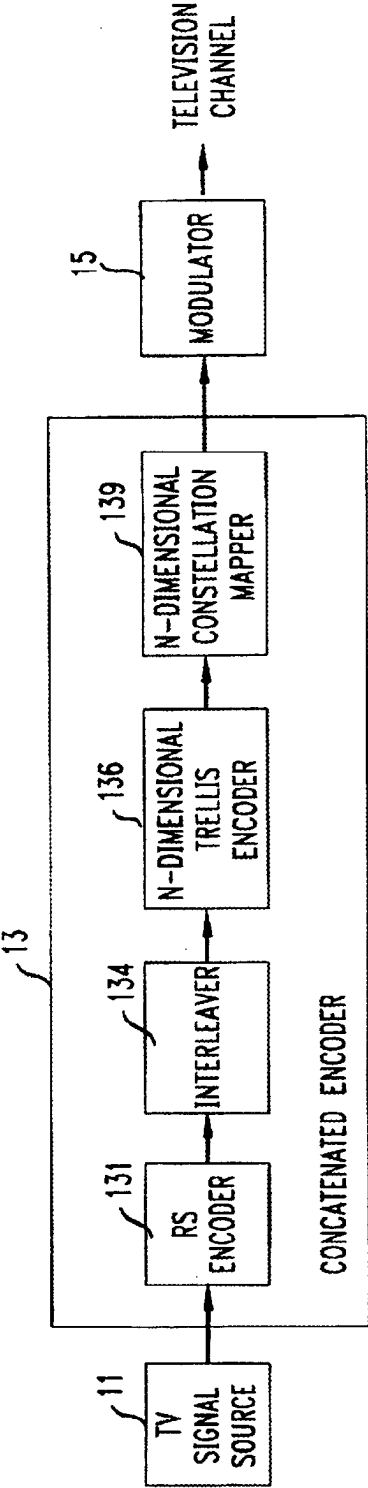


FIG. 2

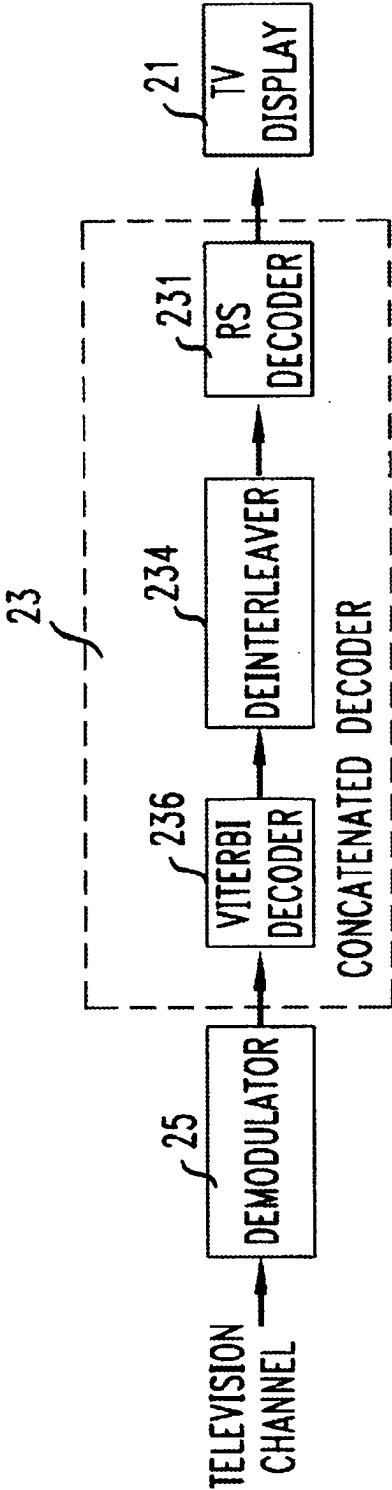
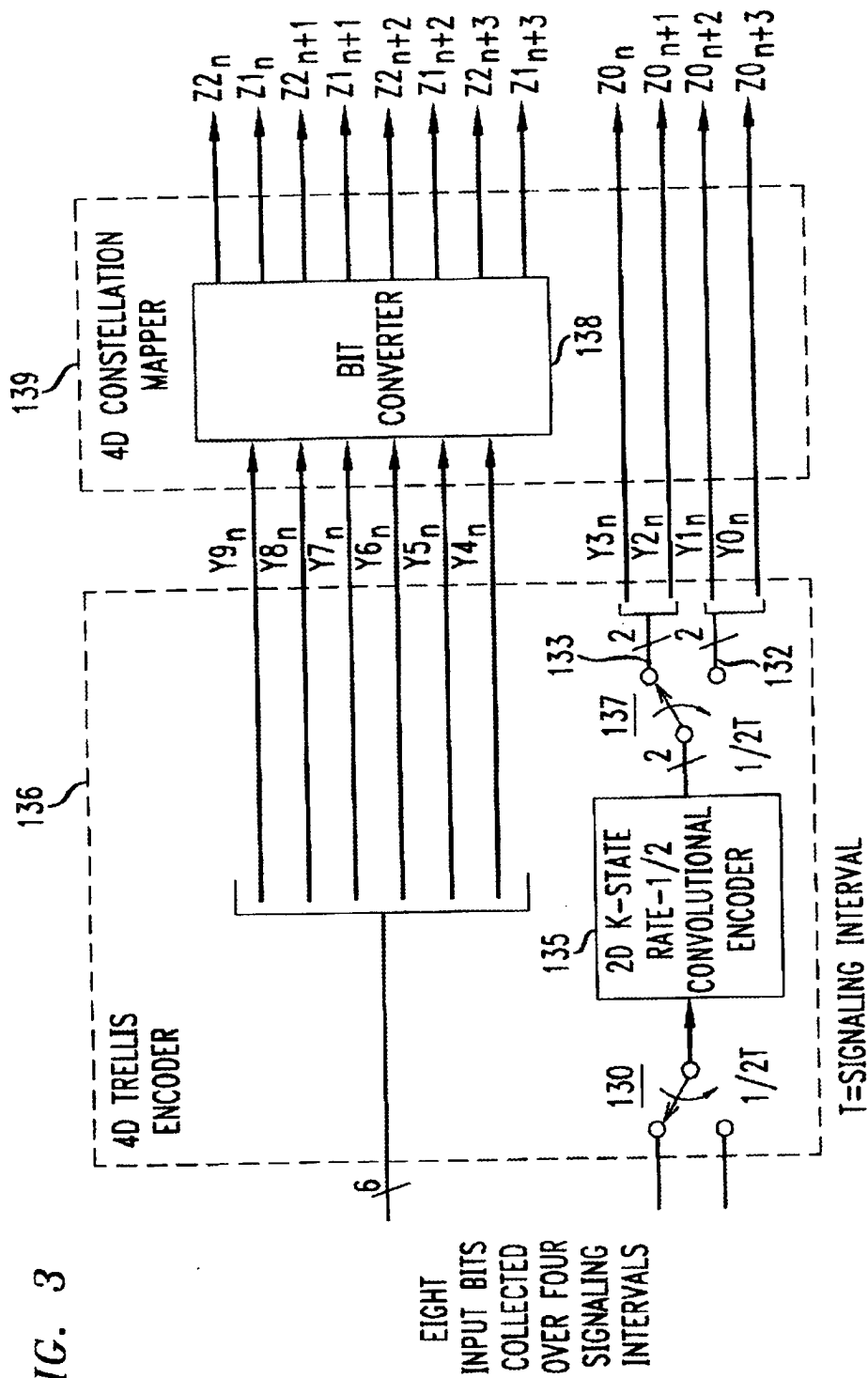


FIG. 3



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FIG. 4

$Y_9 Y_8 Y_7 Y_6 Y_5 Y_4 Y_3$	$Z_2 Z_1$	$Z_{n+1} Z_{n+1}$	$Z_{n+2} Z_{n+2}$	$Z_{n+3} Z_{n+3}$
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1
16	2	0	0	0
17	2	0	0	1
18	2	0	1	0
19	2	0	1	1
20	0	2	0	0
21	0	2	1	1
22	0	2	1	0
23	0	2	1	1
24	0	0	2	0
25	0	1	2	0
26	1	0	2	0
27	1	1	2	0
28	0	0	0	2
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31	1	1	0	2
32	2	1	0	0
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37	1	2	0	1
38	1	2	1	0
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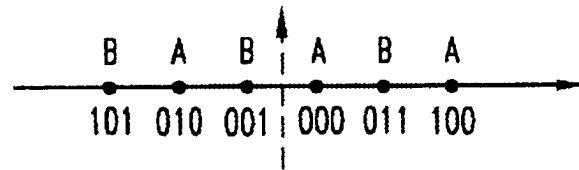
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FIG. 5



BIT PATTERN: $Z_{2m} Z_{1m} Z_{0m}$
 $(m=n, n+1, n+2, n+3)$

FIG. 6

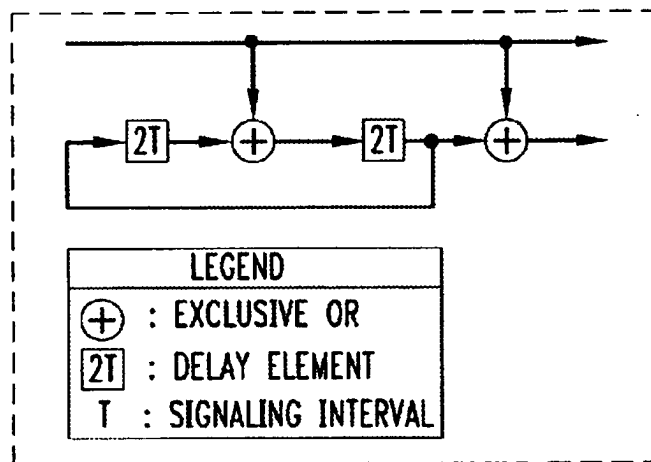
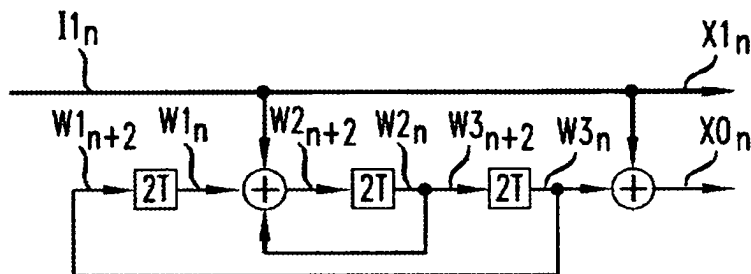


FIG. 7



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FIG. 8

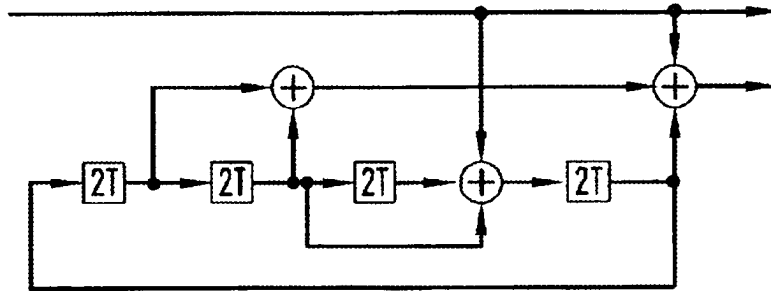


FIG. 9

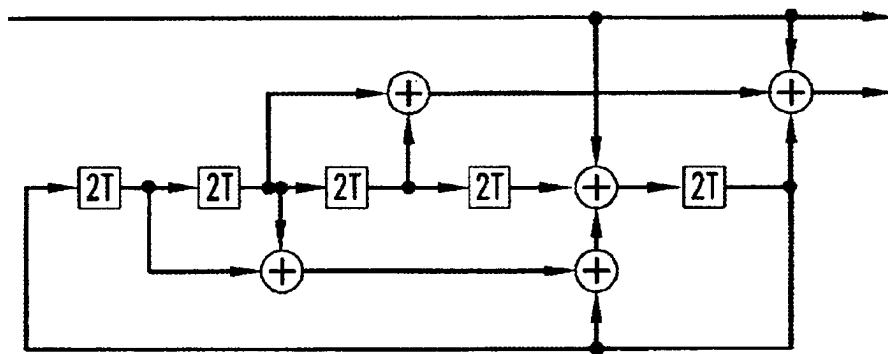
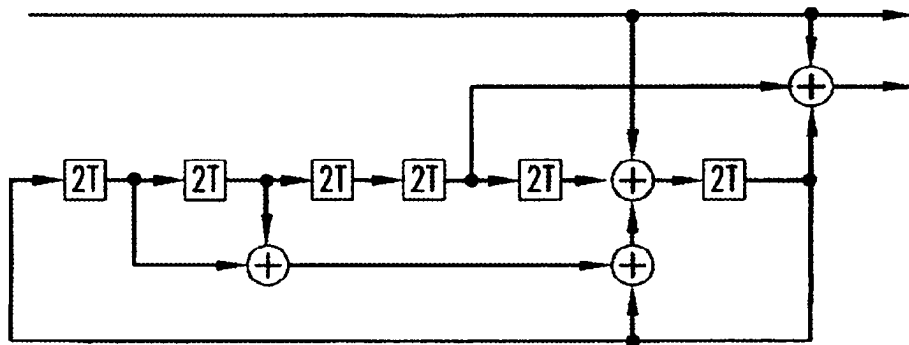


FIG. 10



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TRELLIS CODED MODULATION EMPLOYING LOWER DIMENSIONALITY CONVOLUTIONAL ENCODER

This application is a continuation of application Ser. No. 08/321,363, filed on Oct. 11, 1994, now abandoned.

TECHNICAL FIELD

This invention relates to trellis coded modulation and its application to television systems.

BACKGROUND OF THE INVENTION

Trellis coded modulation schemes have been shown to improve error performance of data links without sacrificing data rate or requiring additional bandwidth. Generally speaking, an N-dimensional trellis coded modulation scheme is constructed by first partitioning an N-dimensional constellation into a number of subsets. The input to the trellis coded modulation scheme in each N-dimensional symbol interval is divided into two portions. A first portion is input to an N-dimensional convolutional encoder whose output bits are used to identify an N-dimensional subset of the constellation. In this case, the convolutional encoder operates only once during each N-dimensional symbol interval. The second portion of input bits remains uncoded and is used to further specify an N-dimensional symbol from the identified N-dimensional subset. The bits identifying both the N-dimensional subset and the N-dimensional symbol are supplied to an N-dimensional constellation mapper. The constellation mapper converts the input bits into an N-dimensional symbol or J P-dimensional signal points, where J and P are integers whose product equals N.

In the prior art, the trellis coded modulation has a dimensionality which is equal to the dimensionality of its associated convolutional encoder. This is the generally accepted design in the art.

Trellis coded modulation has recently been recommended for use in high definition television (HDTV). In an approach proposed by Zenith Corporation to the FCC, the proposed modulation scheme utilizes a concatenated coded, vestigial sideband (VSB) modulator. In the concatenated coder, a Reed-Solomon code is used as an outer code followed by a one dimensional, four state trellis code as an inner code. The VSB modulator uses an eight symbol, one-dimensional constellation. For each successive transmission symbol period, the concatenated coder identifies a particular one of the eight one-dimensional VSB symbols to be transmitted. In this application to HDTV, the trellis coded modulation and its associated convolutional encoder have identical dimensionalities—both are one dimensional. Also, in allowed U.S. patent application Ser. No. 08/226,606, now U.S. Pat. No. 5,398,073 issued Mar. 14, 1995 and in U.S. patent application Ser. No. 08/276,079, higher-dimensional trellis coded modulators and convolutional encoders are used. But consistent with prior art practices, the dimension of the trellis coded modulator is equal to the dimension of its associated convolutional encoder.

SUMMARY OF THE INVENTION

Coding gain is improved in accordance with the principles of the present invention by employing an N-dimensional trellis coded modulator incorporating an N'-dimensional convolutional encoder where N' is less than N. The additional coding gain is realized as a shaping gain. This unique modulator encodes a digital signal by generating a sequence

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of N-dimensional symbols as a function of the digital signal using an N'-dimensional convolutional encoder within the trellis coded modulator more than once (integer N/N' times) during each N-dimensional symbol interval. This allows the trellis coded modulator to produce an output of higher dimensionality than would normally be expected from the lower dimensionality convolutional encoder.

In a specific embodiment of the invention, a two-dimensional (2D) convolutional code is used in a four-dimensional (4D) trellis coded modulation scheme. The trellis coded modulator uses four-dimensional constellation mapping.

In another embodiment, the N-dimensional trellis encoder is used as the inner coder of a concatenated code while an N-dimensional constellation mapper converts the coder output into a sequence of N-dimensional symbols or J P-dimensional signal points where J and P are integers whose product is N. Each P-dimensional signal point is transmitted in a so-called "signalling interval." J P-dimensional signal points are then transmitted in an N-dimensional symbol interval.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention may be obtained by reading the following description of specific illustrative embodiments of the invention in conjunction with the appended drawing in which:

FIG. 1 is a block diagram of a television transmitter incorporating principles of the present invention;

FIG. 2 is a block diagram of a television receiver incorporating principles of the present invention;

FIG. 3 shows a specific implementation of a 4D trellis coded modulator employing a 2D convolutional encoder;

FIGS. 4 and 5 show details of a 4D constellation mapper for use with the 4D trellis coded modulator in FIG. 3; and
FIGS. 6-10 show specific 2D, rate 1/2 convolutional encoders.

DETAILED DESCRIPTION

FIG. 1 shows a block diagram of a television transmitter incorporating a trellis coded modulator realized in accordance with the principles of the present invention. The television transmitter includes TV signal source 11, concatenated encoder 13 and modulator 15.

A television signal such as an HDTV signal is supplied to the concatenated encoder by TV signal source 11. TV signal source 11 includes compression and formatting circuits as well as scrambling circuitry for rearranging the bit stream in a random order.

Concatenated encoder 13 includes the serial combination of Reed-Solomon encoder 131, interleaver 134, N-dimensional trellis encoder 136, and N-dimensional constellation mapper 139. Reed-Solomon encoder 131 is an outer encoder of the concatenated code while an N-dimensional trellis encoder 136 is the inner encoder of concatenated encoder 13. Interleaver 134 operates in a conventional manner to reorder the sequence of Reed-Solomon symbols from encoder 131 thereby providing burst error protection in the receiver. Trellis encoder 136 generates output bits which identify a symbol in an N-dimensional constellation in each N-dimensional symbol interval. It is contemplated that an N-dimensional symbol be transmitted as a sequence of J P-dimensional signal points where J and P are integers whose product is N. N-dimensional constellation mapper 139 converts the modulator output into a

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specific N-dimensional symbol or sequence of J P-dimensional signal points according to a prescribed set of mapping rules. One such set of rules is shown in FIGS. 4 and 5.

Symbols output by concatenated encoder 13 are supplied to modulator 15 for transmission over the television channel. While many modulation schemes are applicable to modulator 15, quadrature amplitude modulation (QAM) and the vestigial sideband modulation (VSB) are presently the modulation techniques of choice for HDTV application. It should be noted that the input to an M-ary VSB modulator is a sequence of one-dimensional ($P=1$) signal points whereas the input to a QAM modulator is a sequence of two-dimensional ($P=2$) signal points. In the description which follows, it will be assumed that modulator 15 is an M-VSB modulator. The symbol "M" indicates that the amplitude of the VSB signal can assume any one of M different values. As such, M is the size of the one-dimensional transmitter constellation implemented by the modulator.

Modulator 15 not only includes standard modulation circuitry, but also includes an interleaver for rearranging the sequence of signal points in such a way that successive signal points generated by concatenated encoder 13 will not appear in succession on the television channel. This additional interleaving insures optimal performance of the convolutional decoder described below. Modulator 15 may also include a Tomlinson precoder as discussed in U.S. patent application Ser. No. 08/276,079, whose teachings are expressly incorporated herein by reference.

Signals output by modulator 15 are applied to a television channel. Exemplary television channels are cable or an over-the-air channel. Signals on a television channel are received by the receiver shown in FIG. 2.

The received signal is applied to demodulator 25. Demodulator 25 performs the inverse operation of each component in modulator 15. For example, demodulator 25 may include a VSB demodulator, an NTSC rejection filter, a channel equalizer, and a de-interleaver. The latter element is used to restore signal points to their original order for subsequent decoding.

The output of demodulator 25 is applied to concatenated decoder 23. Concatenated decoder 23 includes Viterbi decoder 236, de-interleaver 234, and Reed-Solomon decoder 231. Viterbi decoder 236 performs convolutional decoding by the well-known Viterbi decoding technique. The output of decoder 236 is a sequence of interleaved Reed-Solomon symbols. Those symbols are restored to their original order by de-interleaver 234, which performs the inverse operation of interleaver 134. Once in the proper order, the symbols are decoded by Reed-Solomon decoder 231. TV display 21 receives the output of Reed-Solomon decoder 231. The display includes standard circuitry for decompressing (expanding) and reformatting the television signal for presentation on a CRT or other suitable viewing screen.

In the context of the present invention, it will be appreciated by persons skilled in the art that the Viterbi decoder has the same dimensionality as the convolutional encoder in the trellis code modulator. That is, the Viterbi decoder is N-dimensional. This means that the Viterbi decoder, during each processing cycle, processes an N-dimensional input. If the receiver receives P-dimensional inputs, then a sufficient number of those P-dimensional inputs are concatenated to form the N-dimensional input to the Viterbi decoder. The bits output by the Viterbi decoder are collected over an entire

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symbol interval and together are mapped into the bits that correspond to the input to the trellis encoder during the associated N-dimensional symbol interval.

It will be understood by those skilled in the art, although not explicitly shown or described herein, synchronization signals are periodically inserted by modulator 15 into the data stream it receives from concatenated encoder 13. Demodulator 25 recognizes the synchronization signals and responsively generates synchronization control signal which is used by the television receiver to synchronize receiver operations, where necessary, with corresponding transmitter operations.

In various illustrative embodiments, the Reed-Solomon encoder utilizes a so-called RS(208,188) code over GF(256). This means that each Reed-Solomon codeword has 188 data symbols and 20 redundant symbols where each symbol consists of 8 bits. Depending on the degradation of transmission on a television channel, more or less-powerful Reed-Solomon codes can be selected by balancing the need for a particular error-correcting capability against the need for a particular bit rate.

An exemplary 4-dimensional trellis code modulator using a 6-VSB transmitter constellation realized in accordance with the principles of the invention is shown in FIGS. 3-5. In this exemplary embodiment, the trellis encoder is four-dimensional owing to the fact that its associated constellation mapper is four-dimensional and the convolutional encoder within the trellis code modulator is two-dimensional. In this FIG, the notation drawing a slash through a line and placing a number x above the slash is meant to indicate that there are x such input or output leads having the connections of the single line shown in the FIG.

Convolutional encoder 135 utilizes a 2D, K state, rate $\frac{1}{2}$ convolutional code in this example. This encoder accepts one input bit in each pair of signalling intervals and produces two output bits. Since the input bits to trellis encoder 136 are actually collected over four signalling intervals in this example and because this creates two input bits for the convolutional encoder to handle, it is necessary to encode the bits sequentially and thereby produce the four output bits.

In the example depicted in FIG. 3, it is assumed that a first input bit supplied to the convolutional encoder during a symbol interval is collected during its (the symbol interval's) first pair of signalling intervals. Similarly, a second input bit supplied to the convolutional encoder during the same symbol interval is collected during its second pair of signalling intervals.

To this end, the convolutional encoder is augmented by elements 130 and 137, each shown schematically as a switch. Element 130 applies one of the available input bits to the encoder during the first pair of signalling intervals of a symbol interval. In the second pair of signalling intervals of the symbol interval, element 130 applies the second input bit to the convolutional encoder. Element 137 directs the output bits during one convolutional encoding cycle to output lead 133 and then switches the output during the next convolutional encoding cycle to output lead 132. The switching rate for elements 130 and 137 is denoted as $1/2T$, where T is the signalling interval.

Constellation mapper 139 includes bit converter 138 and a plurality of straight-through connections. In this example, the outputs of convolutional encoder 135 are fed straight-through constellation mapper 139 to its output. Uncoded bits from trellis encoder 136 are supplied to bit converter 138. As shown in FIG. 3, bit converter 138 translates its six-bit input

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into an eight-bit output. Bit converter 138 insures that each output bit is derived jointly and interdependently from the input bits. The output bits from constellation mapper 139 are then used to select a four-dimensional symbol or a sequence of four one-dimensional signal points from a 6-VSB transmitter constellation over the four signalling intervals identified in the subscripts as n , $n+1$, $n+2$, and $n+3$.

Operational and realization details of both the convolutional encoder and the bit converter shown in FIG. 3 are well known to persons skilled in this art and, as such, they will not be described further herein.

Each of the sixteen different possible bit patterns represented by the four bits output in each symbol interval from trellis encoder 136 identifies a respective subset of symbols of a four-dimensional constellation. The remaining six bits, so-called "uncoded," bits $Y4_n$ through $Y9_n$ further select a particular symbol from the identified four-dimensional subset.

In particular, the 4D constellation is formed by concatenating four 6-VSB 1D transmitter constellations. The 4D constellation is partitioned into sixteen four dimensional subsets based on a partitioning of its constituent one-dimensional transmitter constellations. FIG. 5 shows how the one-dimensional six-point VSB constellation is partitioned into two subsets, A and B, each subset having three one-dimensional signal points. Each 4D subset is simply a sequence of four 1D subsets. In addition, each 4D subset may be represented as a sequence of two 2D subsets. In the latter case, each 2D subset is merely a sequence of two 1D subsets.

The selection of a particular symbol from the identified four-dimensional subset proceeds as follows: The four bits $Y3_n$, $Y2_n$, $Y1_n$, and $Y0_n$ from convolutional encoder 135 are output by the constellation mapper as four bits, $Z0_n$, $Z0_{n+1}$, $Z0_{n+2}$, and $Z0_{n+3}$, respectively. These bits are then used to select the sequence of one-dimensional subsets which the bits identify.

There are actually 81 possible symbols in each one-dimensional subset sequence, as can be seen from the fact that each one-dimensional subset has three signal points, and $3^4=81$. However, since the six bits $Y4_n$ through $Y9_n$ can represent only 64 different bit patterns, not all of the 81 symbols will actually be used. Rather, it is advantageous for the lookup table of FIG. 4 to map the 64 input bit patterns into the 64 symbols sharing a common characteristic. For example, the symbols may be the smallest energy symbols (the energy of a symbol being simply given by the sum of the squares of the coordinates of its constituent one-dimensional signal points.) To this end, bits $Y4_n$ through $Y9_n$ are applied to bit converter 138 which implements the lookup table shown in FIG. 4. The first pair of output bits of bit converter 138—denoted $Z2_n$ and $Z1_n$ —selects a signal point from the first subset of the one-dimensional subset sequence, which is identified by bit $Z0_n$. The second pair of output bits of encoder 138—denoted $Z2_{n+1}$ and $Z1_{n+1}$ —selects a signal point from the second subset of the one-dimensional subset sequence, which is identified by bit $Z0_{n+1}$, and so forth. FIG. 5 shows the mapping by which the bit values of $Z2_m$, $Z1_m$, and $Z0_m$, for $m=n$, $n+1$, $n+2$ and $n+3$ identify a particular one-dimensional signal point.

Examples of 2D, rate $\frac{1}{2}$, K-static convolutional encoders suitable for use as encoder 135 are shown in FIG. 6 ($K=4$), FIG. 7 ($K=8$), FIG. 8 ($K=16$), FIG. 9 ($K=32$), and FIG. 10 ($K=64$). These encoders are useful as the convolutional encoder for trellis code modulator 136 in FIG. 3.

Specifically, the operations of the convolutional encoder in FIG. 7 can be explicitly described as follows. In each pair

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of signalling intervals, designated by the index " n " for its first signalling interval, the encoder inputs a bit $I1_n$, makes a transition from its current state, $W1_n$, $W2_n$, $W3_n$, to a next state, $W1_{n+2}$, $W2_{n+2}$, $W3_{n+2}$, and outputs two bits $X1_n$ and $X0_n$ where $W1_n$, $W2_n$ and $W3_n$ are the bits stored in the delay elements at the beginning of the pair of signalling intervals, and $W1_{n+2}$, $W2_{n+2}$ and $W3_{n+2}$ are the bits stored in the delay elements at the end of the pair of signalling intervals, and

$$\begin{aligned} X1_n &= I1_n \\ X0_n &= W3_n \oplus X1_n \\ W1_{n+2} &= W3_n \\ W2_{n+2} &= W1_n \oplus W2_n \oplus I1_n \\ W3_{n+2} &= W2_n \end{aligned}$$

Each convolutional code shown in FIGS. 6–10 is designed to maximize the minimum Hamming distance between the sequences of its encoded output bits. Trellis encoders employing these convolutional codes are desirable when concatenated with Reed-Solomon codes, for example. While the Hamming distance feature of the depicted codes is desirable in certain cases, there may be other features such as rotational invariance and the like which may be desirable for the convolutional codes. In any of the cases cited above, it is important to understand that, regardless of the features are selected for the code, the convolutional code must have a lower dimensionality than that of its associated trellis code modulator.

Other state sizes can be used for the convolutional encoder 135 of FIG. 3. Although the exemplary codes are shown as systematic codes, it is understood that non-systematic codes are equally applicable to the present invention.

It is contemplated that rates other than $\frac{1}{2}$, dimensions other than 2, and other various state sizes can be employed in the convolutional encoder used by trellis encoder 136.

In the example described above, VSB constellations have been employed causing P to be equal to 1. As such, each 4D symbol was constructed as a sequence of four 1D signal points. It should be understood that each 4D symbol could also be represented as a sequence of two 2D signal points. In the 6-VSB example, each 2D signal point can be represented as a sequence of two 1D signal points. At the receiver, the Viterbi decoder will process one such 2D point in each processing cycle.

As stated earlier, the present invention is applicable to other modulation systems such as QAM, for example. For the specific example described above, the 4D trellis code modulator will output a pair of 2D signal points in each symbol interval.

In the description above, the invention has been described in the context of integer bit rates. That is, the average number of input bits received in each symbol interval is an integer. In practice, however, it is understood that cases arise wherein the average number of input bits received in each symbol interval is a non-integer. For such cases, it is contemplated that the input to the trellis encoder will be adapted with a fractional bit encoder (not shown) to insure that an integer number of input bits is received by the trellis encoder in each symbol interval, as described in U.S. Pat. No. 4,941,154.

I claim:

1. A method of N-dimensional trellis coded modulation for encoding a digital signal, the method comprising the step of:

generating a sequence of N-dimensional symbols as a function of the digital signal using an N-dimensional

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convolutional encoder, where $N > N' \geq 1$, said encoder being used to generate for each of a plurality of N-dimensional signaling intervals, a plurality of groups of outputs, each said group of outputs being a function of a respective different group of inputs, the N-dimensional symbols comprising J P-dimensional signal points and the digital signal having an integer number of bits per each P-dimensional signal point.

2. The method as defined in claim 1 wherein for each N-dimensional signaling interval, the digital signal is arranged into first and second portions and said first portion is divided into (N/N') groups of bits, the step of generating further including the steps of:

- applying each of said groups of bits sequentially to the N' -dimensional convolutional encoder;
- using output bits from convolutional encoding of all groups of bits included in said first portion to identify an N-dimensional subset of an N-dimensional constellation; and
- using said second portion to specify, jointly and interdependently, the J signal points of an N-dimensional symbol from the N-dimensional subset.

3. The method as defined in claim 2 wherein said subset of said N-dimensional constellation consists of a sequence of (N/N') N' -dimensional subsets, wherein each N-dimensional subset is identified by the convolutional encoder output for a particular group of bits.

4. A method of concatenated encoding a digital signal, the method comprising the steps of:

- Reed-Solomon encoding the digital signal;
- generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N' -dimensional convolutional encoder, said encoder including a finite state machine which advances multiple states for each of a plurality of hi-dimensional signaling intervals, where $N > N' \geq 1$, the N-dimensional symbols comprising J P-dimensional signal points and the Reed-Solomon encoded signal having an integer number of bits per each P-dimensional signal point.

5. The method as defined in claim 4 wherein the step of generating symbols includes the step of interleaving the Reed-Solomon encoded signal.

6. A method of transmitting a digital signal over a television channel, the method comprising the steps of:

- Reed-Solomon encoding the digital signal;
- generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N' -dimensional convolutional code within an N-dimensional trellis code, where $N > N' \geq 1$, said convolutional code being used to generate for each of a plurality of N-dimensional signaling intervals a plurality of groups of outputs each said group of outputs being a function of a respective different group of inputs;
- representing each of said symbols as a sequence of J P-dimensional signal points of a P-dimensional M-ary transmitter constellation, where $J \times P = N$ and the number of bits in the Reed-Solomon encoded digital signal per each P-dimensional signal point is integral;
- generating a modulated signal which represents the resulting sequence of signal point representations; and
- applying said modulated signal to said television channel.

7. The method as defined in claim 6 wherein the step of generating symbols includes the steps of interleaving the Reed-Solomon encoded signal and trellis encoding the resulting interleaved signal.

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8. The method as defined in claim 6 wherein the trellis code is a four-dimensional trellis code and the convolutional code is a two-dimensional convolutional code.

9. The method as defined in claim 8 wherein the convolutional code is a K-state, rate $1/2$ code and K is selected from the group consisting of 4, 8, 16, 32, and 64.

10. The method as defined in claim 6 wherein the television channel is an over-the-air channel and wherein P equals 1.

11. The method as defined in claim 10 wherein the trellis code is a four dimensional trellis code and the convolutional code is a two-dimensional convolutional code.

12. The method as defined in claim 11 wherein the convolutional code is a K-state, rate $1/2$ code and K is selected from the group consisting of 4, 8, 16, 32, and 64.

13. The method as defined in claim 6 wherein the television channel is an over-the-air channel and wherein P equals 2.

14. The method as defined in claim 13 wherein the trellis code is a four dimensional trellis code and the convolutional code is a two-dimensional convolutional code.

15. The method as defined in claim 14 wherein the convolutional code is a K-state, rate $1/2$ code and K is selected from the group consisting of 4, 8, 16, 32, and 64.

16. An N-dimensional trellis coded modulator comprising means for receiving a digital signal, and an N' -dimensional convolutional encoder for generating a sequence of N-dimensional symbols as a function of the digital signal, where $N > N' \geq 1$, said encoder including a finite state machine which advances multiple states for each of a plurality of N-dimensional signaling intervals, the N-dimensional symbols comprising J P-dimensional signal points and the digital signal having an integer number of bits per each P-dimensional signal point.

17. The modulator as defined in claim 16 wherein for each N-dimensional signaling interval, the digital signal is arranged into first and second portions and said first portion is divided into (N/N') groups of bits, wherein the modulator further includes:

- means for applying each of said groups of bits sequentially to the N' -dimensional convolutional encoder;
- means responsive to output bits from convolutional encoding of all groups of bits included in said first portion for identifying an N-dimensional subset of an N-dimensional constellation; and
- means responsive to said second portion for specifying, jointly and interdependently, the J signal points of an N-dimensional symbol from the N-dimensional subset.

18. The modulator as defined in claim 17 wherein said subset of said N-dimensional constellation consists of a sequence of (N/N') N' -dimensional subsets, wherein each N' -dimensional subset is identified by the convolutional encoder output for a particular group of bits.

19. Apparatus for concatenated encoding a digital signal, the apparatus comprising:

- means for Reed-Solomon encoding the digital signal, and
- means for generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N' -dimensional convolutional encoder, said encoder being used to generate for each N-dimensional signaling interval a plurality of groups of outputs, each said group of outputs being a function of a respective different group of inputs, where $N > N' \geq 1$, the N-dimensional symbols comprising J P-dimensional signal points and the Reed-Solomon encoded signal

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having an integer number of bits per each P-dimensional signal point.

20. The apparatus as defined in claim 19 wherein the means for generating symbols includes means for interleaving the Reed-Solomon encoded signal.

21. Apparatus for transmitting a digital signal over a television channel, the apparatus comprising:

means for Reed-Solomon encoding the digital signal;

means for generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N'-dimensional convolutional encoder within an N-dimensional trellis encoder, said convolutional coder including a finite state machine which advances multiple states for each of a plurality of N-dimensional signaling intervals, where $N > N' \geq 1$;

means for representing each of said symbols as a sequence of J P-dimensional signal points of a P-dimensional M-ary transmitter constellation, where $J \times P = N$ and the number of bits in the Reed-Solomon encoded digital signal per each P-dimensional signal point is integral;

means for generating a modulated signal which represents the resulting sequence of signal point representations; and

means for applying said modulated signal to said television channel.

22. The apparatus as defined in claim 21 wherein means for generating symbols includes means for interleaving the Reed-Solomon encoded signal and means for trellis encoding the resulting interleaved signal.

23. The apparatus as defined in claim 21 wherein the trellis encoder is a four-dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

24. The apparatus as defined in claim 23 wherein the convolutional encoder is a K-state, rate $\frac{1}{2}$ encoder and K is selected from the group consisting of 4, 8, 16, 32, and 64.

25. The apparatus as defined in claim 21 wherein the television channel is an over-the-air channel and wherein P is equal to 1.

26. The apparatus as defined in claim 25 wherein the trellis encoder is a four dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

27. The apparatus as defined in claim 26 wherein the convolutional encoder is a K-state, rate $\frac{1}{2}$ encoder and K is selected from the group consisting of 4, 8, 16, 32, and 64.

28. The apparatus as defined in claim 21 wherein the television channel is an over-the-air channel and wherein P is equal to 2.

29. The apparatus as defined in claim 28 wherein the trellis encoder is a four dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

30. The apparatus as defined in claim 29 wherein the convolutional encoder is a K-state, rate $\frac{1}{2}$ code and K is selected from the group consisting of 4, 8, 16, 32, and 64.

31. A method of processing a signal from a communication channel, said signal having been generated by encoding a digital signal using N-dimensional trellis coded modulation, wherein the encoding comprised the step of generating a sequence of N-dimensional symbols as a function of the digital signal using an N'-dimensional convolutional encoder, said encoder including a finite state machine which advances multiple states for each of a plurality of N-dimensional signaling intervals, where $N > N' \geq 1$, the

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N-dimensional symbols comprising J P-dimensional signal points and the digital signal having an integer number of bits per each P-dimensional signal point, the method including the steps of:

5 receiving said signal from said communication channel, and

recovering said digital signal from said received communication channel signal.

32. The method as defined in claim 31 wherein the recovering step includes the steps of:

10 demodulating said received communication channel signal to generate a demodulated signal;

processing the demodulated signal to recover said digital signal.

33. The method as defined in claim 32 wherein the processing step includes the step of Viterbi decoding said demodulated signal by using an N'-dimensional Viterbi decoder.

34. The method as defined in any one of claims 31 through 33 wherein for each N-dimensional signaling interval, the digital signal is arranged into first and second portions and said first portion is divided into (N/N') groups of bits, the step of generating said sequence of N-dimensional symbols further included the steps of:

25 applying each of said groups of bits sequentially to the N'-dimensional convolutional encoder;

using output bits from convolutional encoding of all groups of bits included in said first portion to identify an N-dimensional subset of an N-dimensional constellation; and

using said second portion to specify, jointly and interdependently, the J signal points of an N-dimensional symbol from the N-dimensional subset.

35. A method of processing a signal from a television channel, said signal having been generated by Reed-Solomon encoding a digital signal, generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N'-dimensional convolutional encoder within an N-dimensional trellis encoder, said convolutional coder including a finite state machine which advances multiple states for each N-dimensional symbol interval, where $N > N' \geq 1$, representing each of said symbols as a sequence of J P-dimensional signal points of a P-dimensional M-ary transmitter constellation, where $J \times P = N$ and the number of bits in the Reed-Solomon encoded digital signal per each P-dimensional signal point is integral, generating a modulated signal which represents the resulting sequence of signal point representations, and applying said modulated signal to said television channel, the method including the steps of:

50 receiving said signal from said television channel, and recovering said digital signal from said received television channel signal.

36. The method as defined in claim 35 wherein the trellis encoder is a four-dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

37. The method as defined in claim 36 wherein the convolutional encoder is a K-state, rate $\frac{1}{2}$ encoder and K is selected from the group consisting of 4, 8, 16, 32, and 64.

38. The method as defined in claim 35 wherein the television channel is an over-the-air channel and wherein P equals 1.

39. The method as defined in claim 38 wherein the trellis encoder is a four dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

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40. The method as defined in claim 39 wherein the convolutional encoder is a K-state, rate $\frac{1}{2}$ encoder and K is selected from the group consisting of 4, 8, 16, 32, and 64.

41. The method as defined in claim 35 wherein the television channel is an over-the-air channel and wherein P equals 2.

42. The method as defined in claim 41 wherein the trellis encoder is a four dimensional trellis encoder and the convolutional encoder is a two-dimensional convolutional encoder.

43. The method as defined in claim 42 wherein the convolutional encoder is a K-state, rate $\frac{1}{2}$ encoder and K is selected from the group consisting of 4, 8, 16, 32, and 64.

44. A method of processing a signal from a communication channel, said signal having been generated by concatenated encoding a digital signal using N-dimensional trellis coded modulation, wherein the encoding comprised the steps of Reed-Solomon encoding the digital signal and generating a sequence of N-dimensional symbols as a function of the Reed-Solomon encoded signal using an N'-dimensional convolutional encoder, where $N > N' \geq 1$, said encoder being used to generate for each N-dimensional symbol interval a plurality of groups of outputs, each said group of outputs being a function of a respective different group of inputs, the N-dimensional symbols comprising J P-dimensional signal points and the Reed-Solomon encoded signal having an integer number of bits per each P-dimensional signal point, the method including the steps of:

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receiving said signal from said communication channel, and

recovering said digital signal from said received communication channel signal.

45. The method as defined in any one of claims 34-36 wherein for each N-dimensional signaling interval, the Reed-Solomon encoded signal is arranged into first and second portions and said first portion is divided into (N/N') groups of bits, the step of generating further including the steps of:

applying each of said groups of bits sequentially to the N'-dimensional convolutional encoder;

using output bits from convolutional encoding of all groups of bits included in said first portion to identify an N-dimensional subset of an N-dimensional constellation; and

using said second portion to specify, jointly and interdependently, the J signal points of an N-dimensional symbol from the N-dimensional subset.

46. The invention as defined in any one of claims 4, 16, 21, 31 or 35, wherein said finite state machine that advances N/N' states for each of the plurality of N-dimensional signaling intervals.

47. The invention as defined in any one of claims 1, 6, 19 or 34, wherein said plurality of groups of outputs is comprised of N/N' groups of outputs and said respective different group of inputs is one of N/N' groups of inputs.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 5,706,312

DATED : January 6, 1998

INVENTOR(S) : Lee-Fang Wei

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 7, line 35, change "hi-dimensional" to --N-dimensional--.

line 52, change "outputs each" to --outputs, each--.

Column 9, line 28, change "means for generating symbols" to --the means for generating symbols--.

Column 12, line 5, change "34-36" to --35, 36, or 44--.

line 25, change "34" to --44--.

Signed and Sealed this

Eighth Day of June, 1999

Attest:



Q. TODD DICKINSON

Attesting Officer

Acting Commissioner of Patents and Trademarks

Exhibit 23

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION
CIVIL ACTION NO. 2:05-CV-443 (TJW)

REMBRANDT TECHNOLOGIES, LP,

Plaintiff,

vs.

COMCAST CORPORATION; COMCAST CABLE
COMMUNICATIONS, LLC; and COMCAST
OF PLANO, LP,

Defendants.

*** CONFIDENTIAL TRANSCRIPT ***
ATTORNEYS EYES ONLY

VIDEOTAPED DEPOSITION OF JOSEPH B. KING

Wednesday, November 8, 2006

9:03 a.m. - 2:52 p.m.

Sheraton Sand Key Resort

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Clearwater Beach, Florida 33767

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20 PLANO, LP

21
22 Also Present: Timothy Kyle, Videographer
23
24
25

1 Q Were the applications that you had
2 contemplating -- contemplated running with your
3 invention the same sort of applications as would be
4 running on the multiple virtual DCE?

5 MR. BUNIS: Objection.

6 THE WITNESS: They didn't have to be. Really,
7 this was transparent to the application but, in all
8 reality, it probably would have been. That was a
9 market we were selling into, but it's not restricted
10 to that.

11 BY MR. FERRALL:

12 Q Understood it's not restricted but from a
13 business perspective, you were looking for something
14 that was going to work with similar type applications,
15 right?

16 A I'm sure that was our initial target.

17 Q And just so I understand, those applications
18 would actually run on the remote as well as the master;
19 is that right?

20 MR. BUNIS: Objection.

21 THE WITNESS: That's correct. Both ends, of
22 course, had to serve the same application.

23 BY MR. FERRALL:

24 Q So there would be, for example, some software
25 on the remote that might have allowed you to input sales

Exhibit 24

NEWTON'S TELECOM DICTIONARY

The Official Dictionary of
Computer Telephony, Telecommunications,
Networking and Voice Processing

HARRY NEWTON

World's No. 1 Selling
Telecommunications Dictionary

7th
Expanded
Edition and
Updated
Edition

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SYNCHRONIZATION PULSE A pulse used to achieve or maintain synchronism. The term "synchronization pulse" is usually applied to analog signals, whereas the term "synchronization bit" is usually applied to digital data streams.

SYNCHRONIZING Achieving and maintaining synchronism. In facsimile, achieving and maintaining predetermined speed relations between the scanning spot and the recording spot within each scanning line.

SYNCHRONIZING PILOT In FDM, a reference frequency used for achieving and maintaining synchronization of the oscillators of a carrier system or for comparing the frequencies or phases of the currents generated by those oscillators.

SYNCHRONOUS 1. The condition that occurs when two events happen in a specific time relationship with each other and both are under control of a master clock. 2. Synchronous transmission means there is a constant time between successive bits, characters or events. The timing is achieved by the sharing of a single clock. Each end of the transmission synchronizes itself with the use of clocks and information sent along with the transmitted data. Synchronous is the most popular communications method to and from mainframes. In synchronous transmission, characters are spaced by time, not by start and stop bits. Because you don't have to add these bits, synchronous transmission of a message will take fewer bits (and therefore less time) than an asynchronous transmission. But because precise clocks and careful timing are needed in synchronous transmission, it's usually more expensive to set up synchronous transmission. See ASYNCHRONOUS

SYNCHRONOUS DATA LINK CONTROL SDLC. A data communications line protocol associated with the IBM Systems Network Architecture. See SYSTEMS NETWORK ARCHITECTURE.

SYNCHRONOUS DATA NETWORK A data network in which synchronism is achieved and maintained between data circuit-terminating equipment (DCE) and the data switching exchange (DSE), and between DSEs. The data signaling rates are controlled by timing equipment within the network.

SYNCHRONOUS DIGITAL HIERARCHY SDH. Term used by the International Telegraph and Telephone Consultative Committee to refer to Sonet.

SYNCHRONOUS IDLE CHARACTER A transmission control character used in synchronous transmission systems to provide a signal from which synchronism or synchronous correction may be achieved between data terminal equipment, particularly when no other character is being transmitted.

SYNCHRONOUS NETWORK A network in which all the communication links are synchronized to a common clock.

SYNCHRONOUS ORBIT An orbit, any point on which has a period equal to the average rotational period of the Earth. If the orbit is also circular and equatorial, it is called a stationary (geostationary) orbit.

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power (up to four WATTS permitted) public radio. You do not need permission from the FCC to transmit or receive at these frequencies. Thus CB's great popularity. CB went through a boom (perhaps a craze?), then it ran out of radio frequencies and public enthusiasm. Its original frequencies were 26.965 to 27.225 Mhz. Now the FCC's given it new frequencies — 462.55 to 469.95 MHz. These new frequencies are much better, clearer and less congested. If you buy a CB set, make sure you get one that operates in these higher frequencies. In some countries they use different frequencies. CB radio is not allowed in many countries, even some civilized countries, though it will obviously work there.

CBEMA Computer Business Equipment Manufacturers Association. A lobbying group created to protect the interests of its members.

CBF Computer Based Fax.

CBK Change Back.

CBR Constant Bit Rate. It refers to processes such as voice that require a constant, repetitive or uniform transfer of information.

CBTA Canadian Business telecommunications Alliance. The largest organization of business telecom users in Canada.

CBX Computerized Branch eXchange. CBX is a registered trademark of the Rolm Corporation, Santa Clara, CA. Rolm is now owned by Siemens and IBM, but largely by Siemens. What CBX is to Rolm, PBX or PABX is to other companies. The term CBX has not received wide acceptance, except at Rolm.

CBX II A Rolm communications controller for larger systems. Two versions exist: the CBX II 8000 (16-bit CPU) and the CBX II 9000 (32-bit CPU).

CCC 1. Clear Coded Channel. A 64 kbps channel in which all 64 kbps is available for data. 2. Clear Channel Capability. The bandwidth of a data transmission path available to end users after control and signaling bits are accounted for. 3. Communications Competition Coalition. Lobbying organization established to encourage competition in telecommunications in Canada.

CCD 1. Charge Coupled Device. The "eyes" of a scanner or "digital camera." CCDs are small electronic devices with arrays of light-sensitive elements. The number of these elements and the width determine the scanner's or camera's resolution. Light is bounced off the image onto the CCD, which translates the varying intensities of the reflected light into digital data. CCD technology is used also in "digital still cameras" such as the Sony Mavica. The small size of the array itself — approximately microchip size — and the high resolution — around 1,000 by 1,018 elements — of these cameras have greatly improved "image acquisition" capabilities and opened up new applications in manufacturing quality control and in medicine. 2. Change Coupled Device.

CCDN Corporate Consolidated Data Network. An IBM word.

CCFL Cold Cathode Fluorescent Lamp. A technology several laptop computer manufacturers use to light their LCD screens.

CCIA Coalition of services (lobbying) bers. See

CCIR C (Consultants) Also used Europe. T be 1,125.

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IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

REMBRANDT TECHNOLOGIES, LP

v.

COMCAST CORPORATION; COMCAST
CABLE COMMUNICATIONS, LLC; AND
COMCAST OF PLANO, LP

Civil Action No. 2:05-cv-00443-TJW

ORDER

ON THIS DAY came on to be heard Plaintiff's Unopposed Motion for Leave to Exceed the Page Limits, and the Court is of the opinion that the Motion should be GRANTED.

Accordingly, IT IS ORDERED that the Plaintiff's Unopposed Motion for Leave to Exceed the Page Limits is GRANTED.